THE

RUBBER RESEARCH INSTITUTE

OF

MALAYA

IMPERIAL MYCOLOGICAL
19 OCT 1937
INSTITUTE

ANNUAL REPORT 1936

Published by
The Rubber Research Institute of Malaya
and printed by
Kyle, Palmer & Co., Ltd.,
Kuala Lumpur, F.M.S.

August 1937

Price $1/-

THE RUBBER RESEARCH INSTITUTE OF MALAYA

MEMBERS OF THE BOARD

at the 31st December 1936

The Director of the Institute (Mr. H. J. PAGE, M.B.E.)	Chairman, *ex officio*
The Hon'ble the Financial Adviser, F.M.S.	Financial Member (appointed by the High Commissioner under section 5 (i) (b) of the Enactment (Cap. 108)
The Hon'ble the Director of Agriculture, S.S. and Adviser on Agriculture, Malay States	*Ex officio*
CHE HAMZAH BIN ABDULLAH, M.C.S. Orang Kaya Kaya Stia Bi-jaya di-Raja, Perak CHE MOHAMED NOORDIN BIN ABDUL SHUKOR, I.S.O.	appointed by the High Commissioner under section 5 (i) (d) of the Enactment (Cap. 108)
Mr. A. P. CRANNA Mr. CHOO KIA PENG, C.B.E., J.P. Mr. J. S. FERGUSON, J.P. Mr. J. C. INNES, J.P. The Hon'ble Mr. B. J. R. BARTON	appointed by the High Commissioner under section 5 (i) (e) of the Enactment (Cap. 108)

THE PERMANENT COMMITTEE

The Director of the Institute	Chairman, *ex officio*
The Hon'ble the Financial Adviser, F.M.S.	Financial Member, *ex officio*
Mr. A. P. CRANNA Mr. CHOO KIA PENG, C.B.E., J.P. Mr. J. C. INNES, J.P.	appointed by the High Commissioner under section 13 (i) (c) of the Enactment (Cap. 108)

CONTENTS

	Page
Report of the Board	1
Statement of Accounts	6
Report of the Director	14
„ „ „ Soils Division	39
„ „ „ Botanical Division	52
„ „ „ Pathological Division	77
„ „ „ Chemical Division	99
„ „ „ Experiment Station	119
Report of the London Advisory Committee for Rubber Research (Ceylon and Malaya)	143

Publications

Publications of the Rubber Research Institute are issued in the following forms at prices stated at time of publication :

(a) **Planting Manuals**—being articles of an instructional nature primarily for estates' use. These appear at irregular intervals.

(b) **Bulletins**—being articles of special scientific interest printed and bound separately, appearing occasionally

(c) **Journal**—being articles by officers of the Institute on current work, appearing at irregular intervals as information accumulates during the year

(d) **Annual Reports** of the work of each Division during each year, with a summary by the Director R.R.I.

(e) **Information Cards**—being concise precis of the processes of estate factory practice.

The following publications have been issued and copies can be obtained on application at the prices given against each :—

(a) PLANTING MANUALS

No. 1 "Guide to the Preparation of Plantation Rubber" by B. J. Eaton ... $2.00

No. 2 "Budding of Hevea in Modern Plantation Practice" by F. Summers (out of print)

No. 3 "Plantation Sheet Rubber Manufacture" by R. O. Bishop ... $2.00

No. 4 "Latex Preservation and Shipment" by R. O. Bishop and R. G. Fullerton ... $2.00

No. 5 "The History and Description of Clones of Hevea Brasiliensis" by C. E. T. Mann and C. C. T. Sharp Illustrated by H. C. Chuan ... $2.00

Stiff cover for filing the leaflets ... $1.00

No. 6 "The Uses and Control of Natural Undergrowth on Rubber Estates" by W. B. Haines (out of print)

Binder cover for filing the Manual ... $0.50

(b) BULLETINS

No. 1 "Natural Coagulation of Hevea Latex" by A. S. Corbet (out of print)

No. 2 "A Study of the Effect of Damp Storage on Raw Rubber" by B. J. Eaton and R. G. Fullerton ... $1.00

No. 3 "The Root Disease Problem on Old Rubber Areas in Malaya" by A. Sharples and A. R. Sanderson ... $1.00

No. 4 "Summary of Meteorological Records, Soils Division" by W. B. Haines ... $1.00

No. 5 "Variations in the Composition of Latex from Clone and Seedling Rubber" by J. L. Wiltshire ... $1.00

(c) JOURNAL OF THE R.R.I.

Vol. 1 Nos. 1, 2—two numbers combined ... $1.00

Vol. 1 „ 3, 4
Vol. 2 „ 1, 2, 3, 4
Vol. 3 „ 1, 2, 3
Vol. 4 „ 1, 2
Vol. 5 „ 1, 2, 3, 4
Vol. 6 „ 1, 2
Vol. 7 „ 1, 2

each number ... $0.50

(d) ANNUAL REPORTS

from 1928 each ... $1.00

(e) INFORMATION CARDS

dealing with various phases of Rubber Estate Factory Practice and Defects in Raw Rubber

in Malaya ... $0.50
outside Malaya ... $1.00

Bank commission should be added to outstation cheques.

REPORT OF THE BOARD

FOR THE

YEAR ENDED 31ST DECEMBER, 1936

THE BOARD

The constitution of the Board is as prescribed by Enactment no. 14 of 1934 and the personnel at the 31st December, 1936, was

(a) The Director of the Institute—
Mr. H. J. Page, M.B.E. (*Chairman*)

(b) The Treasurer and Financial Adviser, F.M.S.
The Hon'ble Mr. H. R. Joynt, M.C.S.

(c) The Director of Agriculture, S.S., and Adviser on Agriculture, Malay States—
The Hon'ble Mr. O. T. Faulkner, C.M.G.

(d) Members representing the interests of small-holders—
Che Hamzah bin Abdullah, M.C.S.
Che Mohamed Noordin bin Abdul Shukor, I.S.O.

(e) Members nominated by Planting Associations—
*Mr. A. P. Cranna
*Mr. J. C. Innes, J.P.
*Mr. Choo Kia Peng, C.B.E., J.P.
Mr. J. S. Ferguson, J.P.
The Hon'ble Mr. B. J. R. Barton

*These members continued to serve on the Permanent Committee.

Lieut. Col. B. J. Eaton, O.B.E., who was Director of the Institute from July 1929 to August, 1936, and Chairman of the Board from June, 1934, retired from Malaya on the 14th August, 1936, and was succeeded by Mr. H. J. Page.

Dr. H. A. Tempany, C.B.E., who was a member of the Board from April, 1929, retired from Malaya on the 23rd May, 1936, and was succeeded in November by Mr. O. T. Faulkner, C.M.G. In the interregnum Mr. F. W. South served on the Board as acting Director of Agriculture, S.S., and Adviser on Agriculture, Malay States.

MEETINGS OF THE BOARD AND COMMITTEES

During 1936 the meetings of the Board and Committees were

Board—ordinary meetings	3
Permanent Committee	4
ad hoc Committees	3
	10

THE REVENUE OF THE INSTITUTE

From the beginning of 1936 until the 30th September the contributions from the Colony of the Straits Settlements, the Federated Malay States and the Unfederated Malay States continued to be made as stated in the Annual Report for 1935, that is, from the Rubber Funds established by the Rubber Regulation Ordinance of the Straits Settlements and the analogous Enactments of the Federated Malay States and the States of Johore, Kedah, Kelantan and Trengganu. In addition, the State of Brunei contributed for the first time, at the same rate as the other Administrations, *viz.* 4½ cents per pikul of the basic quota allotted under the International Rubber Regulation Agreement.

On the 1st October, 1936, the Straits Settlements Ordinance and the Federated Malay States Enactment were repealed and replaced by a new Ordinance and a new Enacment, and similar amending legislation was enacted in the Unfederated Malay States. The effect of the amending legislation, so far as it concerned the Rubber Research Institute, was to establish one Malayan Rubber Fund, out of which, *inter alia*, the Institute is supplied with funds for account of all Malayan territories except the State of Brunei, which will continue to negotiate direct with the Board.

The contributions received for the year 1936 are:—

	$ c.
Federated Malay States ...	223,776.00
Johore	105,084.00
Kedah	46,471.32
Kelantan	12,285.00
Trengganu	5,216.40
Brunei	1,512.00
Straits Settlements	38,480.40
	$432,825.12

Fire at the Institute

On the 24th September, 1936, a fire broke out in the Chemical Division of the Institute and destroyed that and the Soils Division, including practically all the plant, machinery, apparatus and furniture in the two Divisions. These were covered by insurance and the claim has been settled.

The work of the two Divisions has necessarily been curtailed but new equipment has been ordered and will be installed in the new buildings erected for the Institute.

New Buildings for the Institute

In the Report for 1935 it was reported that the Board had decided to erect new offices and laboratories on Ampang Road, Kuala Lumpur, which it was expected would be ready for occupation during the second half of 1936; the foundation stone was laid on the 22nd April 1936, by H.H. the Sultan of Selangor. Unfortunately, the equipment of the laboratories was delayed and it is now proposed to enter into occupation in March, 1937.

Accounts for the year 1936

Subjoined are the Income and Expenditure Account for the year 1936 and the Balance Sheet as at the 31st December, 1936.

The income for the year was—		
Contributions from Administrations		$ 432,825 12
Interest, Sales of rubber, publications, etc., House rentals	...	32,784 24
		465,609 36
The Board's investment of $172,800 in F.M.S. 4½% Loan was sold and realised	...	213,616 72
Compensation received for plant, machinery, apparatus, furniture and books destroyed by fire was	...	81,429 65
		$ 760,655 73

This was utilised as follows:—		
Recurrent expenditure, including the replacement of some of the goods destroyed ...		491,466 95
Special expenditure on—		
Plant and Machinery ...	14,948 29*	
Furniture for Houses ...	321 95	
Furniture for Laboratories ...	4,739 51*	
Laboratory Equipment & Apparatus ...	21,350 32*	
Experiment Station Development	12,499 80	
New Buildings on Ampang Road	226,179 17	
Improvements to land on which the new buildings are erected ...	2,283 32	
Lease of small area of rubber land	1,036 00	$ 283,358 36
		$ 774,825 31

*These amounts include the cost of certain items on Capital Account to replace losses by fire.

From the balance sheet it will be observed that the total excess of assets over liabilities is $1,422,976.63 represented by

Land, Buildings and Furniture		$621,165 80
Plant, Machinery and Apparatus		47,986 07
Experiment Station		464,959 49
Stocks		1,862 25
Sundry Debtors		51,652 10
Investments		163,012 12
Cash		155,345 72
		$1,505,983 55
Less Sundry Creditors Miscellaneous ...	$60,344 83	
Reserve for Staff leave-pay and passages	16,015 23	
Rubber Roadways Committee—balance of grant from the Rubber Experimental Research and Propaganda Fund	6,646 86	83,006 92
		$1,422,976 63

The realisable investments and available cash amount to approximately $287,000.

Small-holders' Advisory Service

Six appointments of Asiatic Rubber Instructors were made in 1936, and one Instructor was invalided out of the service, leaving a total of 19 Instructors on duty at the close of the year. One of the Instructors was sent to Brunei for service in that territory.

The original cadre of 22 has been increased to 24, the Board having approved one appointment in Brunei and the appointment of one Instructor to be stationed at the R.R.I. Experiment Station, Sungei Buloh. There therefore remain five appointments to be made to complete the establishment, and it is hoped to make these in 1937.

Activities of the Institute in 1936 and 1937

The work of the Institute in the last quarter was considerably hampered by the fire which destroyed the Chemical and Soils Divisions on the 24th September, and although it is expected to enter into occupation of new laboratories by the end of March, 1937, it will be near the end of the first half-year before these two Divisions will be working to capacity.

Arrangements have been made for the appointment of one additional Botanist, two Advisory Officers and one Junior Assistant for the Experiment Station, and it is expected these officers will arrive before the end of the first half of 1937. In addition, the appointment of a Statistician has been approved.

H. J. Page

Chairman of the Board

H. S. Blacklin

Secretary

Kuala Lumpur,

25th February, 1937

INCOME AND EXPENDITURE ACCOUNT

Dr.

EXPENDITURE

		$	c.	$	c.
To	Experiment Station			68,396	45
„	Board and Committees (Fees and Expenses) ...			1,479	33
„	London Advisory Committee			11,953	36
„	London Secretarial Fees and Expenses			878	99
„	Salaries and Allowances			203,786	80
„	Provident Fund			21,370	62
„	Staff Leave Pay and Passages			34,925	79
„	Rubber Roadways Research			8,533	33
„	Medical			2,445	85
„	Travelling			11,801	01
„	Office General Charges (Printing, Stationery, Postage, Telephone, Audit and Legal) ...			5,900	38
„	Staff Recruiting			366	00
„	Rents, Rates and Insurance			3,466	17
„	Laboratory General Charges			1,203	24
„	Maintenance Buildings (Offices and Residential Houses)			7,856	37
„	Maintenance Laboratory Grounds			1,108	48
„	Repairs and Renewals Furniture			675	57
„	Repairs and Renewals Fixtures and Fittings ...			2,786	49
„	Plant and Machinery (Repairs and Running Expenses)			5,626	49
„	Power, Lighting, Water and Sanitation ...			3,101	25
„	Lorry (Running Expenses)			2,161	00
„	Workshop			285	70
„	Laboratory and Office Apparatus and Glassware			27,691	57
„	Laboratory Chemicals			7,319	37
„	Publications issued by the Institute			4,016	88
„	Library (New Books, Subscriptions to Periodicals and Sundries)			5,845	82
„	Exhibitions and Demonstrations			903	45
„	Small Holders' Advisory Service:				
	Film Propaganda	1,463	14		
	Asiatic Rubber Instructors	24,192	95		
	Grant to Department of Agriculture for Vernacular Publications	2,000	00	27,656	09
„	Bad Debts written off			111	74
„	Experiments (Field and Testing Laboratory) ...			16,841	88
„	New Buildings:				
	Miscellaneous Expenditure written off ...			4,231	59
„	Depreciation for year			43,047	53
„	Balance being Excess of Income over Expenditure for year carried to Balance Sheet			12,026	67
				$549,801	76

KUALA LUMPUR,
5th February, 1937

FOR THE **YEAR** ENDED **31st DECEMBER, 1936**

Cr.

INCOME

		$	c	$	c.
By	Contributions from Administrations for the year			432,825	12
„	Interest on Cash and Investments			6,483	43
„	Profit on sale of Investments			29,694	65
„	Miscellaneous Receipts:				
	Sales of Rubber and Budwood	19,720	81		
	Sales of Publications	1,624	90		
	House Rentals	4,690	09		
	General	265	01	26,300	81
„	Balance of compensation received under fire insurance policy in respect of fire damages, after deducting book values of fixed assets destroyed			54,497	75
				$549,801	76

(Sgd.) H. S. BLACKLIN
Secretary

(Sgd.) H. J. PAGE
Chairman of the Board

BALANCE SHEET AS AT

LIABILITIES

	$ c.	$ c.
SUNDRY CREDITORS:		
On Open Account	28,662 53	
On Bills Payable	4,286 41	
For Goods in Transit and on Order	26,304 86	59,253 80
DEPOSITS FOR PUBLICATIONS		1,091 03
RESERVES:		
Staff Leave Pay and Passage:		
Laboratory	14,100 26	
Experiment Station	1,914 97	16,015 23
RUBBER ROADWAYS COMMITTEE		6,646 86
EXCESS OF ASSETS OVER LIABILITIES:		
Balance as at 1st January, 1936	1,410,949 96	
Add Excess of income over expenditure for year	12,026 67	1,422,976 63
Carried forward ...		1,505,983 55

31st DECEMBER, 1936

ASSETS

	$ c.	$ c.	$ c.
LAND AND BUILDINGS :			
132 Ampang Road			
Land as at 1.1.36		10,755 00	
Ampang Villa as at 1.1.36	15,234 96		
Less Depreciation for year	1,523 49	13,711 47	
132a Ampang Road			
Building as at 1.1.36	34,630 45		
Less Depreciation for year	3,463 02	31,167 43	55,633 90
Land behind Ampang Villa			
As at 1.1.36			5,029 35
5 Circular Road :			
Land as at 1.1.36		17,147 08	
Old Building as at 1.1.36	11,866 59		
Less Depreciation for year ...	1,186 66	10,679 93	
Three houses as at 1.1.36 ...	62,674 23		
Less Depreciation for year ...	6,267 42	56,406 81	84,233 82
163 Ampang Road :			
Land as at 1.1.36		31,440 35	
Old Building as at 1.1.36 ...	11,019 14		
Less Depreciation for year ...	1,101 91	9,917 23	
Five houses as at 1.1.36	73,869 15		
Less Depreciation for year ...	7,386 91	66,482 24	107,839 82
184/8 Ampang Road :			
Land as at 1.1.36	45,422 50		
Less Transferred to New Laboratory Buildings ...	17,840 00	27,582 50	
Five houses as at 1.1.36	67,581 59		
Less Depreciation for year ...	6,374 66	61,206 93	88,789 43
Land at Ampang Road under lease ...		1,036 00	
Less Depreciation for year		103 60	932 40
LABORATORY BUILDINGS :			
As at 1st January, 1936		1 00	
New Laboratory Buildings and land :			
Value of land transferred ...	17,840 00		
Add Cost of Improvements ...	1,600 00	19,440 00	
Building as at 1.1.36	1,172 51		
Additions during year	223,601 88	224,774 39	244,215 39
PLANT AND MACHINERY :			
Electric Plant as at 1.1.36	1,297 04		
Less Depreciation for year	324 26	972 78	
Carried forward ...		972 78	586,674 11

BALANCE SHEET AS AT

LIABILITIES—*(Contd.)*

	$ c.
Brought forward ...	1,505,983 55
Carried forward ...	1,505,983 55

31st DECEMBER, 1936

ASSETS—*(Contd.)*

	$ c.	$ c.	$ c.
Brought forward ...		972 78	586,674 11
PLANT AND MACHINERY *(Contd.)*			
General Machinery as at 1.1.36 ...	9,613 22		
Less Loss by fire	9,613 22		
Add additions during year	14,948 29	14,948 29	15,921 07
FURNITURE			
Residential Houses :			
As at 1st January, 1936	24,010 21		
Add additions during year ...	321 95		
	24,332 16		
Less Depreciation for year ...	2,401 02	21,931 14	
Office :			
As at 1st January, 1936	7,970 64		
Less Depreciation for year ...	797 06	7,173 58	
Laboratory :			
As at 1st January, 1936	1,678 48		
Less Loss by fire	1,678 48		
Add additions during year ...	4,739 51	4,739 51	
Library :			
As at 1st January, 1936	719 40		
Less Depreciation for year ...	71 94	647 46	34,491 69
LABORATORY EQUIPMENT AND APPARATUS			
As at 1st January, 1936	27,601 77		
Less Loss by fire	15,353 84		
	12,247 93		
Add additions during year	21,350 32		
	33,598 25		
Less Depreciation for year	2,449 59		31,148 66
MOTOR LORRY			
As at 1st January, 1936		645 79	
Less Depreciation for year		161 45	484 34
WORKSHOP EQUIPMENT			
As at 1st January, 1936		508 24	
Less Depreciation for year		76 24	432 00
R.R.I. EXPERIMENT STATION			
Development Expenditure as at 1st January, 1936		461,769 35	
Add additions during year		12,499 80	
		474,269 15	
Less Depreciation for year		9,309 66	464,959 49
LIBRARY BOOKS AND PERIODICALS			
As at 1st January, 1936		1 00	
Add Purchases during year ...		4,261 10	
		4,262 10	
Less written off		4,261 10	1 00
Carried forward ...			1,134,112 36

BALANCE SHEET AS AT

LIABILITIES—*(Contd.)*

	$ c.
Brought forward ...	1,505,983 55

(Sgd.) H. S. BLACKLIN
Secretary

(Sgd.) H. J. PAGE
Chairman of the Board

$1,505,983 55

I hereby certify that to the best of my knowledge and belief, all

Kuala Lumpur,
5th February, 1937

We have audited the above Balance Sheet and Income and Expenditure
Malaya, and certify same to be correct according to the best of our information

Kuala Lumpur,
16th February, 1937

31st DECEMBER, 1936

ASSETS—*(Contd.)*

	$ c.	$ c.	$ c.
Brought forward ...			1,134,112 36
STOCKS			
Petrol and Oil:			
Laboratory	248 23		
Experiment Station	39 08	287 31	
Empty Drums:			
Laboratory	118 00		
Experiment Station	92 00	210 00	
Stationery		590 66	
Sundry Materials:			
Laboratory	157 13		
Experiment Station ...	643 45	800 58	1,888 55
SUNDRY DEPOSITS (Water, Telephones etc.)			
Laboratory		230 00	
Experiment Station		20 00	250 00
SUNDRY DEBTORS			
Administrations		35,942 76	
Staff		12,359 58	
Accrued Interest		650 00	
General		453 77	
At Experiment Station		1,104 96	50,511 07
SUSPENSE			
Laboratory		266 68	
Experiment Station		597 05	863 73
INVESTMENTS			
4½% Singapore Municipal Loan Nominal value $15,000/- ...		17,536 69	
British 3½% War Loan, 1932/54 Nominal value £17,000/- ...		145,475 43	163,012 12
CASH AT BANK AND IN HAND			
Chartered Bank, London		2,999 96	
Chartered Bank, Kuala Lumpur			
Board's Account	87,735 71		
Rubber Roadways Committee ...	6,646 86		
Working Account	55,073 71		
Experiment Station	2,506 43	151,962 71	
Petty Cash			
Secretary 121 09			
Imprest Advance ... 110 00	231 09		
Experiment Station ...	151 96	383 05	155,345 72
			$1,505,983 55

liabilities to 31st December, 1936, have been brought into account.

(Sgd.) H. S. BLACKLIN
Secretary

Account with the books and vouchers of the Rubber Research Institute of and the explanations given to us and as shown by the books of the Institute.

(Sgd.) GIBSON, ANDERSON, BUTLER & CO.
Chartered Accountants
Auditors

ANNUAL REPORT

OF

THE DIRECTOR

Introduction

The present writer was in charge of the Institute for only the last 4½ months of the year, so that this report refers, for the most part, to work and activities which occurred under the direction of his predecessor. The work of the Divisions and of the Experiment Station will therefore be summarised and discussed here less fully than normally, leaving the reader to refer to the reports of the Divisions and the Experiment Station for fuller information.

Although the incidence of home leave, and of vacancies in the staff, was less severe in 1936 than in 1935, it was still sufficient to prevent the work of the Institute from attaining its full scope. After March the Botanical Division had three research officers on duty, but two further vacancies remained still unfilled at the end of the year. The research officer whose duties consisted of advisory work for both the Soils and Chemical Divisions was absent on home leave for the first five months of the year, but otherwise these Divisions were at full strength until the beginning of December, when one officer of the Chemical Division went on home leave. The appointment of an additional research officer for advisory work for the Soils Division was decided upon towards the end of the year, so that in future the Botanical, Soils and Chemistry Divisions will each have the full-time services of a research officer for advisory work. The inevitable delays which have occurred hitherto in dealing with advisory work, and which have been aggravated by a considerable increase in the amount of such work during the year, will then be mitigated. One of the research officers of the Pathological Division went on home leave early in May, and for the rest of the year only one research officer was on duty in that Division.

A still more serious hindrance to the work of the Institute resulted from the disastrous fire which destroyed the Chemical and Soils Divisions' laboratories on 24th September. Particulars of this are given in the *Journal*, Vol. 7, Part 2, pp. 110—112. The immediate effect of this fire was completely to stop all laboratory work of the two Divisions in question for the rest of the year, besides interfering with their advisory work, and, to a lesser extent, with the normal work of the Botanical and Pathological Divisions.

Details relating to the staff of the Institute are given below.

Staff

Director

The writer arrived in Malaya, and took over the duties of Director on 14th August, on which date Lt. Col. B. J. Eaton retired from the service of the Institute.

Botanical Division

Mr. C. C. T. Sharp, Botanist, acted as Senior Botanist, in charge of the Division, until the return of Mr. C. E. T. Mann, Senior Botanist, from home leave on 11th March.

Dr. E. D. C. Baptist arrived in Malaya and took up the post of Botanist on 20th March.

The vacancies for two further Botanists will be filled in 1937.

Chemical Division

Dr. E. Rhodes, Senior Chemist, in charge of the Division, Dr. K. C. Roberts, Chemist, and Mr. J. H. Piddlesden, Chemist, were on duty throughout the year.

Mr. J. D. Hastings, Chemist, went on home leave on 4th December.

Mr. A. Moore, Chemist, returned from home leave on 31st May, and resumed his duties of carrying out advisory work for this Division and for the Soils Division.

Pathological Division

Mr. F. Beeley, Pathologist, went on home leave on 8th May, and for the remainder of the year Mr. R. P. N. Napper, Pathologist, was in charge of all the work of the Division.

Soils Division

Mr. C. G. Akhurst, Senior Soils Chemist, in charge of the Division, and Mr. R. A. Hamilton, Soils Chemist, were on duty throughout the year. As stated under Chemical Division, Mr. A. Moore resumed his duties in respect of the advisory work of this Division on his return from home leave on 31st May. The vacancy for another Soils Chemist will be filled in 1937.

Administration

Mr. H. S. Blacklin, Secretary and Librarian, was on home leave from 20th March until 19th October. During this time the post was filled by the temporary appointment of Mr. T. G. Wiggins, except for a few weeks at the beginning of the period, when Mr. W. L. Crick officiated.

Experiment Station

Mr. H. W. Foston, Manager, was on home leave from 19th March to 21st November, during which period Mr. T. N. Dickson, Assistant Manager, acted as Manager, whilst Mr. R. D. Stonehewer was temporarily appointed to act as Assistant Manager for the same period. The appointment of a Junior Assistant at the Experiment Station was decided upon towards the end of the year, and the post will be filled in 1937.

Statistician

An appointment to fill the newly-created post of Statistician will be made in 1937.

Advisory Work

The hindrances to the prompt execution of advisory work, owing to shortage of staff and to the fire at the Institute, have been referred to above. In spite of this, the amount of advisory work done shows a considerable expansion over the previous year, reflecting the increasing demand by the planting industry for the services of the scientific staff of the Institute.

Particulars of the advisory services given will be found in the reports of the Divisions.

The following table summarises this aspect of the work of Divisions in connection with requests for advice and with experiments on estates:—

	Botanical	Chemical	Pathological	Soils	Total
Visits to estates (excluding Experiment Station) ...	400	233	98	322	1,053
Interviews at the Institute	164	221	79	110	574
Lectures ...	2	2	1	10	15
Letters received ...	1,831	1,158	840	1,375	5,204
Letters sent ...	1,805	1,406	1,053	1,617	5,881
Specimens and samples received for examination and/or analysis ...	233	658	706	850	2,447
Tours of advisory visits*	11	10	6	20	47

* These tours were distributed among States and Settlements as follows:—

Johore, 13; Malacca, 4; Negri Sembilan, 7; Selangor, 6; Pahang, 2; Perak, 8; Penang and Province Wellesley, 1; Kedah, 6.

These figures show a marked increase over 1935 under nearly all headings; the volume of such work handled by the Botanical and Soils Divisions was about doubled in each case, as compared with 1935.

Many of the enquiries to the Chemical Division related to smoke-house design, and a revised pamphlet on the Subur type of smoke-house was issued. Many other enquiries related to latex-preservation and concentration, coagulants, and estate machinery.

A large proportion of the enquiries to the Soils and the Botanical Divisions referred to replanting problems from such aspects as manuring, covers, methods of planting, and choice of planting material. Many other enquiries referred to manuring of mature rubber, and to problems of soil conservation by covers or otherwise.

The enquiries received by the Pathological Division included a large number on the subject of root-disease control and eradication, especially in connection with replanting.

Much of the correspondence, interviews, and visits referred to above was in connection with the scheme of experimental planting of reserve areas, which underwent considerable development during the year. Further reference to this is made later in this report.

Small-Holders' Advisory Service

During the year six new Asiatic Rubber Instructors were recruited. Five of these were from the School of Agriculture at Serdang. The sixth was a man with many years' experience in the Department of Agriculture, who was recruited specially for service in Brunei where he works for both the Institute and the Department. One Malay Rubber Instructor left the service owing to illness, so that at the end of the year there were 14 Malay, 3 Chinese, and 2 Indian Rubber Instructors, who were distributed as follows:—

Perak	2 Malays
	1 Chinese
	1 Indian
Selangor	1 Malay
	1 Chinese
Negri Sembilan ...	1 Malay
	1 Indian (part time in Selangor)
Pahang	2 Malays
Johore	2 Malays
	1 Chinese

Kedah	...	2 Malays
Kelantan	...	1 Malay
Brunei	...	1 Malay
Malacca	...	1 Malay
Penang and Province Wellesley	...	1 Malay
Total	...	19

It is intended to recruit two Malays and three Chinese in 1937, bringing the total up to 24. This is two more than was originally intended, the extra men being necessary because of sending a Rubber Instructor to Brunei and because in November 1936 it was decided that there should always be one Rubber Instructor at the Institute's Experiment Station at Sungei Buloh.

The Small-Holders' Advisory Service is now well established. Progress at the beginning was naturally slow, but the Instructors have succeeded in gaining the confidence of the small-holders and there is no longer any doubt as to the good effects of their work.

When the service was started, its primary object was to improve the quality of the rubber prepared on small-holdings. This was the most pressing need, and was also the most easily dealt with. The small-holder in most cases required to spend little or no money to improve his product—all that were necessary were care and cleanliness and a very cheap smoke-house. The high quality of the exhibits sent in 1936 to the rubber competitions at Agricultural Shows throughout the country was proof of the success of our propaganda in this direction.

A further striking proof of the improvement in the quality of the rubber produced by small-holders lies in the fact that manufacturers in Europe and America actually complained of a shortage of lower-grade blanket-crepe. This blanket-crepe is remilled from low-quality sheet produced mainly on small-holdings. It possesses certain qualities desired by manufacturers and was normally appreciably cheaper than first-class smoked sheet. During 1936 this crepe was produced in smaller quantities, because there was available less of the low-grade sheet from which it is made. This lessening of the supply of low-grade sheet is caused partly by the selling of "coupons" (export rights for rubber) by small-holders, with consequently less production; but an important factor is that small-holders are now producing better sheet, and smoking it also. This better sheet is exported without further treatment. It does not need to be remilled into blanket-crepe, as was the case with the low-grade sheet formerly produced on almost all small-holdings.

The smoke-house for small-holders, introduced in 1935, is still proving popular. By the end of 1936 the Rubber Instructors had helped to build over 200, and an unknown number had been built by small-holders themselves. Nearly 40 were built for demonstration at various shows, where on account of their obvious simplicity and cheapness they were popular exhibits.

In some parts of the country the small-holders gain considerably by smoking their own rubber. In other parts there have been complaints that it is not worth while. Enquiry into some of these cases revealed that where it was not worth while for a small-holder to smoke his own rubber the reason was that the rubber dealers had greatly lowered their charges for smoking or, alternatively, were paying almost the same price for unsmoked as for smoked sheet. Before the introduction of these smoke-houses, dealers charged 80 cents to $1.00 per picul for smoking rubber on behalf of small-holders, at a time when the price of rubber was less than $20 per picul. Now, with the price of rubber about double that figure, the dealers' charges for smoking have been reduced to half. It is thus evident that presence of these smoke-houses on small-holdings, even if in some cases they are not used regularly, is sufficient to protect the small-holder from some unfair exploitation.

With the rise in price of rubber during 1936, small-holders are able to undertake improvements which involve spending money. There is still a general reluctance to do this—the small-holder prefers to spend as little as possible and to draw what he can—but there are now signs of a widening outlook. Budgrafting has been done on a few holdings, replanting is under consideration on several, and some of the more progressive small-holders are even thinking of manuring. There is also more willingness to spend money on the control of disease. Formerly the only disease to be treated regularly was Mouldy Rot, the treatment of which is compulsory. Now the control of root and branch-diseases is receiving attention, and will help greatly in prolonging the life of rubber trees on small-holdings.

Ground conditions on small-holdings generally have been improved during the year. The Rubber Instructors try to teach the use and control of desirable jungle plants but holders are rather afraid of encouraging them in case it leads to their receiving a lower assessment. Some bunding on steep hillsides has been done, and in the low-lying districts drainage has been improved on many holdings.

Not much progress has been made with regard to tapping. During the slump the owners of holdings usually did the tapping themselves, but were obliged to tap drastically in order to get a

living. Now, with the improved price of rubber, coolies are hired to tap. These often work on contract, without regular supervision, and will not act on any advice given to them. The result is that on a large proportion of holdings which are in tapping the bark-consumption is still two or three times that allowed on well-managed estates. The situation generally is, however, relieved by the fact that small-holders often sell their "coupons" (export rights for rubber) and do not tap systematically.

A conference of Asiatic Rubber Instructors was held at the Institute in August, following the Malayan Agri-Horticultural Show at which all the Instructors were on duty. The conference was held in conjunction with a short refresher course, and enabled the Instructors to exchange views and to obtain advice direct from officers of the Institute. A similar conference will be held each year in future, as it provides an opportunity for personal contact between the headquarters staff and the Rubber Instructors, which would not otherwise be possible.

Rural Lecture Caravan

The Rural Lecture Caravan jointly operated by the Co-operative Societies Department, S.S. & F.M.S., the Department of Agriculture, S.S. & F.M.S., and this Institute, has continued its tours of lectures and demonstrations on the same lines as in previous years, with the co-operation of Rubber Instructors whenever possible.

The following tours have been made in 1936:—

Selangor	Ulu Langat	Eight centres
Perak	Kinta	Ten „
	Perak North	Four „
	Dindings	Four „
	Krian	Eight „
Penang and Province Wellesley	Province Wellesley	Six „
	Penang	Two „
Malacca	Central	Three „
	Alor Gajah	Four „
	Jasin	Two „
Negri Sembilan	Port Dickson	Four „
	Seremban	Six „
	Kuala Pilah	Seven „
Pahang	Raub	Seven „
	Temerloh	Fourteen „
	Kuala Lipis	Four „

In addition, the Caravan was present at the Agricultural Show at Batu Pahat, Johore.

Co-operation with other Institutions

The Director has continued to serve on the Advisory Committees of the Department of Agriculture, S.S. & F.M.S., and of the School of Agriculture, Malaya; on the Marketing and Propaganda Committee of the Co-operative Societies Department, S.S. & F.M.S.; and on the Public Gardens' Committee (Kuala Lumpur).

Co-operation with the various bodies mentioned on page 23 of the Directors' report for 1935 has continued on the same lines as there stated. Further details of some aspects of this will be found in the report of the Chemical Division, and in that of the London Advisory Committee and the Appendix thereto.

Co-operation with the Rubber Research Scheme of Ceylon was much assisted by the visit to Malaya, in November and December, of Mr. R. K. S. Murray, Botanist and Mycologist on the staff of that Scheme, and Mr. E. W. Whitelaw, a member of its Board of Management, together with Mr. W. G. Berry, Visiting Agent for the Grand Central Rubber Co. These gentlemen were accompanied by the Director, the Senior Botanist, and other members of the staff of the Institute, on a tour of estates in Malaya, and Mr. Murray returned to Malaya after visiting the Netherlands Indies, in order to spend further time at the Institute and the Experiment Station.

Mr. C. E. T. Mann, Senior Botanist, in charge of the Botanical Division of the Institute, also spent two weeks in Ceylon on his way back from home leave early in the year, when he was able to visit and confer with the staff of the Ceylon Rubber Research Scheme and to visit rubber estates in Ceylon. Personal contacts during exchanges of visits of this kind are of the utmost value in fostering co-operation between the organisations concerned.

Agricultural Shows (Malaya)

As in previous years, the Institute staged an exhibit at the Exhibition of the Malayan Agri-Horticultural Association in Kuala Lumpur, whilst the Chemical Division was responsible for arranging and staging the smoked sheet rubber for the All-Malaya Small-Holders' rubber competition, and it also provided judges for that competition.

So far as possible exhibits, including the Small-Holders' smoke-house developed by the Institute, were staged at District Agricultural Shows.

Soil Problems

Replanting

There was a marked increase in the amount of attention shown by estates to replanting during the year.

Much of the replanting was only tentative, and a preliminary to commencing more extensive operations in 1937. The total amount of replanting which has been started in 1936 is, therefore, small in comparison with the amount permissible under the scheme of Rubber Restriction.

Manuring is being done in nearly all instances of replanting, but there is only meagre information available concerning the precise manurial requirements of young replanted rubber seedlings. Comprehensive experiments have been started by the Institute, which will provide this information.

Manuring

General interest in the manuring of rubber trees has been much greater and is due to a steadily-growing appreciation of the improvements which are possible by the use of suitable fertilisers. Experimental evidence is still very incomplete, although interesting results have been published from some field experiments carried out by Dunlop Plantations Ltd. and Imperial Chemical Industries (Malaya) Ltd., and there are numerous aspects still awaiting detailed investigation.

Experimental Planting

The experimental planting of a limited portion of estate reserve land, as permitted by the International Rubber Regulation Agreement, has been developed into a comprehensive scheme, and experiments under the direct supervision of the Institute are now in hand, of which those of special concern to the Soils Division deal with the following points—comparison of different methods of opening jungle; relative values of different types of covers in young clearings; the best age at which to commence manuring; the comparison of the effects of fertilisers on different clones on different soils types. Further reference to this work is made below under "Botanical Problems." A statement showing particulars of this scheme is attached to this report as an appendix, and the reports of the Soils and Botanical Divisions should also be consulted.

Cover Plants

Considerable interest has been shown by estates in cover plants, both cultivated leguminous and "natural" types. The value of covers in old rubber is now well appreciated and also, if the rubber trees are to get maximum benefits, the necessity for supplementing them with manures. The establishment of leguminous covers in a mature rubber area is still a matter of difficulty, and

is receiving special consideration, particularly from the point of view of inoculation with the nitrogen-fixing nodule organism. Laboratory work, pot-culture trials and field experiments have been planned by the Institute to investigate this problem.

Laboratory Work

During 1936 laboratory work on soils problems was brought to a stand-still in September owing to the complete destruction of the laboratories and offices of the Soils Division by fire. Before then, a large number of soil profiles from all parts of the country had been sampled and analysed, and data were being accumulated for the purpose of studying and differentiating the soil types found on Malayan rubber lands. Work had been commenced on the fixation and availability of phosphates in Malayan soils; an investigation was being made of the value of rubber leaf-analysis as a means of assessing the nutrient requirements of rubber trees, and also preliminary work on nitrification in the soil had started. None of these laboratory investigations could be continued after the fire until the Institute's new buildings were occupied, and in most cases the data accumulated were burned.

Botanical Problems

The principal subjects of investigation have been the study of methods of improvement of the standard of Hevea planting material, tapping methods and the more purely botanical aspects of methods of cultivation.

Improved Planting Material

Early in 1936 experimental plots established on the Institute's Experiment Station during the years 1929 and 1930 reached the tapping stage and considerable progress has been made in the study of buddings of the well-known clones, clonal seedlings, seedlings obtained by artficial pollination between selected parents and new clones established from seedling crosses of known high-yielding parentage.

The data obtained during two tapping years on young budded trees of the well-known clones confirm very closely the records of the first tests on the small original groups of trees from which propagation for commercial planting on a large scale has been made.

The early results from tapping of seedling families obtained by means of cross-pollination between high-yielding clones have shown that the yields of the best families of seedlings may be equal to those of buddings of the best clones. Generally, the

illegitimate seedling families from good clones *i.e.* seedlings grown from the seed collected from budded trees of the clone without any attempt to control pollination, do not give yields of the same high order as the best crosses, but they are nevertheless much superior to ordinary unselected seedlings. Certain clones appear to be of outstanding value as parents of high-yielding seedlings.

From the crosses of known parentage, clones were made in 1930 and 1931 and it has been possible to study both the mother trees and buddings made from them under closely comparable conditions. A number of the new clones established in this manner have given yields of from 7 to 13 pounds dry rubber per tree in the first tapping year. Yields of this order are appreciably greater than those obtained from buddings of the best of the present proved clones available for commercial planting.

The increased interest in replanting has resulted in renewed interest in the selection of improved planting material. The choice between clonal seedlings and buddings of the best proved clones must be made. On the evidence available the advice of the Institute must be that buddings of the best proved clones constitute the most reliable material at present available for large-scale planting. Although seedling trees may possess certain advantages over budded trees, the proved superiority in the yield of the latter remains the deciding factor for the present. Conclusive proof of the quality of yield of seedlings and buddings has only been obtained from a comparison of small families of legitimate crosses between pairs of selected parents and buddings of the best clones. It has not yet been proved that it is feasible to produce, in quantities sufficient for large-scale commercial planting, seedlings of the same order of merit as the small families of seedlings which have been the source of available yield data up to the present time.

Tapping Systems

Comparison of different tapping systems on mature seedling trees has been continued in the experiment set up by the Institute on Seventh Mile Estate in 1933. The results obtained to the end of the third year show that there is a general tendency for the yields obtained on the lighter tapping systems to increase slowly in relation to the control—alternate-daily tapping on half-circumference without rest. Bark-thickness measurements taken in renewed bark after three years fail to demonstrate that periodic resting has had any appreciable effect so far on the rate of bark renewal. In systems which involve tapping simultaneously on two cuts on half-circumference one on each side of the tree, the rate

of bark renewal above the tapping cuts appears to be accelerated and below, retarded, in relation to the control.

Comparison of alternate-day tapping with A.B.C. and tapping every third day, on young budded trees of a number of proved clones, has demonstrated a loss in total yield approximately proportional to the reduction in the frequency of tapping. There is no evidence so far that for the clones studied the trees tapped on the lighter systems have benefited by the additional rest.

Tapping of budded trees of two clones, Pilmoor B.84 and D.65, has been continued without rest since May 1929. During the year 1936 tapping has been continued on renewed bark and no change in the trend of yield has been observed. Budded trees of these two clones have yielded 21 and 23 pounds of dry rubber respectively in the 12th year of age.

Cover Plants

In collaboration with the Soils Division a study of the growth of young rubber trees under different methods of cultivation has been continued. The growth of rubber trees is being studied on hilly areas in association with various types of leguminous cover plants and with indigenous plant species which become established after the clearing of the primary jungle. Up to the third year of age growth of rubber trees in association with indigenous species is entirely satisfactory, but it must be emphasised that work of this nature must be continued for a period of several years before reliable conclusions can be drawn from the records.

Experimental Planting

The Botanical Division has been closely concerned with the Soils Division in the preparation of schemes of experimental planting for areas approved for this work (see under "Soils Problems" above). The schemes of experiments of special concern to the Botanical Division under this arrangement are those dealing with the further testing of proved clones, the testing of hitherto unproved clones, the testing of families of legitimate and illegitimate "clonal" seedlings, the study of the influence of density of planting, the study of the best time at which to commence tapping, and various other problems. Further reference should be made to an appendix to this report, and to the report of the Botanical Division.

Other Investigations

Other work in progress includes the investigation of methods of injection of trees with dilute nutrient solutions, the object being

to develop a simple method for the diagnosis of nutrient deficiencies. A study of root development has also been commenced, the aim being to ascertain whether well-defined phases of active root-development occur. This information is required in connection with other studies on the time of application of fertilisers.

Pests and Diseases

Leaf and Stem Diseases and Pests

The usual seasonal work in the field gave further support to the conclusion that weather and environment are of paramount importance when considering the occurrence and virulence of the leaf-mildew fungus *Oidium Heveae*. In general it can be said that the foliage and seed set in the old rubber were even better than in 1935, and that the incidence of *Oidium Heveae* in the new leaf was practically nil up to the 10th March, and thereafter was mild and occurred only in the later-wintering trees. Various preparations of sulphur dust for use against *Oidium* were tested.

The occurrence of leaf- and stem-diseases of budded clones continues to receive attention as a result of which the importance of water-relationships and various nutritional factors is more generally realised as a cause of certain pathological conditions in young rubber trees arising from what are now regarded as bad agricultural practices.

During the dry weather experienced from February onwards, and even at the end of the year when heavy rains are normally the rule, the leaf spot fungi *Helminthosporium Heveae*, *Gloeosporium Heveae*, *Colletotrichum* sp. and *Scolecotrichum* continued to give considerable trouble in nurseries and in young rubber trees in the field.

The thrips pest of leaves of rubber trees was again prevalent on many estates in the west coastal districts of Malaya this year, but in very few cases was sulphur-dusting to check this pest really needed.

Mouldy Rot

The wet weather experienced in January enabled further tests of various proprietary fungicides to be carried out, and again towards the end of the year testing of a further four tar-distillate fungicides in control of Mouldy Rot was commenced.

Root-Diseases

Greatly increased interest was taken during the year in problems of *Root-Disease* control and requests for information and

advice, particularly with regard to mature areas, were received from all parts of the country. Widespread interest in root-disease control was also shown in connection with replanting. High mortality from root-disease is one of the major causes of reduction in the stand of mature rubber trees, and it is of great importance when replanting old heavily-diseased areas to insure if possible against a repetition of these losses in the replanted stand.

Considerable areas were replanted during the year, methods of clearing ranging from simple tree-felling, with no stump- or root-removal, to clean-clearing, followed by deep digging and complete root extraction. From the point of view of root-disease control, selective clean-clearing of disease patches, with a minimum of root-removal in the healthy areas, would appear to be the most economical policy. Experiments to investigate this problem are to be laid down by the Institute in 1937.

Pests and Diseases of Cover Plants

Further reports have been received during the year of cover plants being attacked by fungi which are also parasites of the rubber tree. Among the most common are the three root-disease fungi and Pink Disease. The more woody-stemmed plants seem to be the chief of those reported to be attacked by Pink disease, *e.g. Crotalaria* spp. *Tephrosia* spp. *Indigofera* spp. and *Desmodium ovalifolium*. The growing of heavy covers of these plants in districts known to be susceptible to Pink Disease should be avoided.

Reports continue to be received of cover plants being attacked by a Rust fungus of the group *Uridinales*, susceptible hosts being *Crotalaria* and *Tephrosia* spp.

Cut-worms (larvae of various species of *Noctuid* moths) caused damage to bush covers in young clearings in many parts of the country. Some of the outbreaks were severe, but all were restricted to small areas and were sporadic in character. Mealy-bugs (*Pseudococcus* spp.) were more in evidence than usual, though damage was restricted mainly to cover crops. Epidemic outbreaks of Nettle-grubs (*Limacodidae*) were reported from two estates in northern Perak.

Termites

Termites (*Coptotermes curvignathus*) continued to cause serious damage throughout the country, especially in young areas of rubber trees between the ages of 4 and 10 years.

Cockchafer Grub

The year was marked by a notable increase in the incidence of the Cockchafer pest (*Psilopholis grandis*). At the beginning of

the year ten estates were known to be infested in various parts of the country, but during the months of June to December this number was more than doubled, the greatest increase occurring in the district south-east of Seremban. The sudden rise in activity of this pest is not properly understood and in order to obtain information on this and related questions, a descriptive pamphlet-cum-questionnaire was prepared for general circulation to estates. There is still considerable doubt concerning the true economic importance of the pest. It is hoped that the repliès to the questionnaire will help to settle this controversial matter.

Bacteriological Work

Bacteriological work during the year consisted chiefly of the continuation of the investigation into the effect of manuring on soil bacterial numbers and the effects of various seasons of the year.

Replanting

Towards the end of 1935 a questionnaire was circulated to estates known to have enquired at the Institute on the subject of replanting old areas of rubber. This questionnaire contained some 21 questions on the various operations to be observed before, during and after replanting. From the 96 estates circularised some 46 replies were obtained and the answers to the various questions analysed. A brief report on the results was prepared.

Chemical Problems, and Estate Factory Practice

In many ways the effect of the fire in September was more serious for the Chemical Division than for the Soils Division, for much of the experimental work of the latter is necessarily done in the field in any case, whereas the experimental work of the Chemical Division is done for the most part in the laboratories of the Institute, the destruction of which therefore brought that work almost to a standstill. Fortunately, however, one chemical laboratory, being situated in the main building, escaped destruction, and it was therefore possible for the more urgent laboratory work of the Division to be carried on, albeit under most congested conditions.

Latex Constituents

Work on this subject was continued and developed throughout the year, and a paper describing the main results of the first stage of the investigation was published.

The isolation and characterisation of the various "complexes" constituting latex is expected to assist very materially in the elucidation of many problems, both fundamental and practical. Of the former, the most important is that of the mechanism of latex and caoutchouc formation in the tree, whilst among practical problems germane to this work are those of the changes occurring during storage of ammoniated latex, and the factors responsible for variations in the composition and properties of latex at different times of the year and as between different trees or clones.

Latex Preservation

Much work has been devoted to the development of improved tests for assessing the quality of latex before and after storage, and to the study of factors causing, and methods of avoiding deterioration. Among the former may be mentioned the stirring-stability test, the boric acid test for putrefactive odour, and the test for colour; whilst the latter includes the study of protective coatings for the interior of storage and shipment vessels; and attempts to find a satisfactory alternative to ammonia as a preservative. Work on the viscosity and surface tension of latex, and their variations with concentration has an important bearing on the study of latex-preservation problems, as well as the obvious relation to the work next referred to.

Latex Concentration

The search for new creaming agents has continued, but so far nothing better than Tragon A has been found, though certain promising lines are still being followed up.

Work on centrifugal concentration was held up after the return to the makers, halfway through the year, of the machine referred to in last year's report. It is intended to resume this work, with other machines, in 1937.

An experimental plant designed in the laboratories of the London Advisory Committee is being used for experiments on the concentration of latex by evaporation.

The study of concentration of latex by filtration is also in progress, though it is yet only in its early stages.

Copper in Latex

The dangers of copper contamination from the use of brass sieves has been emphasized already, and during the year a paper dealing with experiments on the subject was published. Fresh uncontaminated latex has been found to have a small but definite natural content of copper, so that it is impossible to guarantee latex as copper-free, though, with proper working, it can be guaranteed as free from extraneous copper.

Modified Rubbers

Promising results have been obtained from the testing of small samples of low water-absorption rubber obtained by the papain-digestion of latex, and large-scale tests by cable manufacturers are being carried out, whilst work is continuing with the object of simplifying the procedure for the preparation of such rubber, so as to make it more suitable for operation on estates.

The prevailing belief among some manufacturers that light-coloured sheet is hard, and dark coloured sheet soft, has been shown not to be well-founded. Hard and soft sheets may occur indiscriminately, whether among consignments of lightly or of heavily-smoked sheet. Other variations in estate factory procedure have little effect on the plasticity of the rubber produced; the wide variations met with in commercial rubbers must be caused by inherent differences in the caoutchouc in the latex, or by drying conditions. The former appears to be an important factor; work on this, and on methods for producing artificially modified natural rubbers, of unusual softness, was interrupted by the fire, but will be resumed in 1937.

Clone Rubber

Work on the variation in vulcanisation, ageing and plasticity, as between the rubber from different clones, was carried out until September, one of the most interesting findings being that the rubber from two clones appeared to be consistently softer than that from others, or than that from ordinary seedling rubber. The quantitative data from this work were unfortunately lost in the fire.

The Drying of Rubber

It has been shown that, in the presence of smoke, the ageing properties of rubber are little influenced by time and temperature of drying, within reasonable limits, but that continued heating in absence of smoke, after adequate smoke-drying, causes impaired ageing properties.

A critical investigation of the factors involved in the drying of rubber has been carried out, one object of which is to provide a scientific basis for the design of improved forms of drying plant. The results indicate that little is to be gained by forced-draught; that after an initial period of good natural ventilation, drying should continue with much restricted ventilation, with temperature regulation such as to allow raised temperature as soon as the sheet is dry enough to stand it; and that for rapid drying the sheet should be about 1/10th inch in thickness. The Subur type of smoke-house fulfils these requirements tolerably well, but further

improvements in smoke-house design will be tested on the practical scale in 1937.

The work so far carried out indicates that the modern type of smoke-house is unlikely to be superseded by other types differing radically in principle.

Experiment Station

New planting was confined to the planting of the former elephant belt adjoining certain blocks, to an area of 19 acres, in addition to which 9½ acres of old nursery sites were planted.

A general manuring programme for areas judged to need it for purposes of maintenance or improvement, was decided upon, to be carried out in 1937. Much of the light sandy soil on the flat areas at the Experiment Station is inherently poor in its plant-food-content, and fair average growth can be expected only if this is supplemented by manuring, including the supply of potash, which the results of the manuring experiment on Block 6 indicate to be necessary.

Special scaffolding has been erected around a number of selected trees in preparation for hand-pollination work in 1937.

Interesting results are being obtained from the various experiments in which covers and their effects are being studied, notably Block 27 and Block 11. Reference should be made to the Manager's report for details (pp 126—129).

The total area in tapping during the year was 431.25 acres, of which, however, in certain areas only a proportion of the trees were being tapped. A large proportion of the latex has to be coagulated in the cups, for the purpose of the experiments, so that less than half the total output is in the form of sheet. Over 80,000 samples, mostly cup lump, have to be dried, weighed and recorded every month.

Various small new buildings were erected, and preparation made for more extensive additions in 1937.

A new type of enlarged "kampong" smoke-house, with a capacity of 3,600 lb. of rubber, and drying ⅛" sheet in five days, was erected at a total cost of $70/-.

A new 6-roller sheeting battery, and a 3-roller creping battery, were installed, also a bulking tank designed in the Chemical Division.

Courses of instruction in budgrafting, pest and disease work, and factory practice, were given to five Europeans and over 40 conductors and kanganies.

Visitors

The number of visitors to the Institute during the year, as shown by the visitors' book, was 398, whilst the Experiment Station had 555 visitors, many coming in parties organised by District branches of the Incorporated Society of Planters, or by District Planting Associations.

The Institute was visited by His Excellency the Governor, S.S., and High Commissioner for the Malay States on the 19th May.

Among visitors from outside Malaya were:—

Messrs. F. D. Ascoli, (Dunlop Plantations Ltd., London), C. Barclay, (H. A. P. M., Sumatra), W. G. Berry, (Ceylon), W. G. Birnie, (Anloc, Indo-China), M. Bocquet, (Terres Rouges, Indo-China), W. T. L. Ten Broeck, (Goodyear Co., Sumatra), A. W. D. Brooke, (Kuching, Sarawak), W. E. Cake, (H. A. P. M., Sumatra), R. Thion de la Chaume, (Anloc, Indo-China), W. G. Cookson, (Kaban Djahe, Sumatra), P. J. S. Cramer, (Holland), J. Dessain, (S. I. P. E. F., Antwerp), T. Fukaya, (Taihoku Imperial University, Japan), M. Katashima, (Japan), Ph. de Langlois, (Socfin Ltd., Paris), W. T. Lewis (Firestone Co., Akron, U.S.A.), E. M. McColm (H. A. P. M., Sumatra), G. H. Masefield, (Member of the London Advisory Committee for Rubber Research), R. K. S. Murray, (Rubber Research Scheme, Ceylon), G. M. Oehm, (American Cyanamid Co., New York), C. Ritchie (Cairo (Malay) Rubber Syndicate, Ltd.), de Sauzière (Indo-China), Rao Bahadur M. R. Ramaswami Sivan, (Coimbatore, Madras), F. Tanaka, (Taihoku Imperial University, Japan), W. R. Thomson, (Colombo), A. de Vogue, (Anloc, Indo-China), E. W. Whitelaw, (Ceylon), and H. N. Whitford, (Rubber Manufacturers Association, New York).

General

During the year one issue of the Institute's *Journal* (Vol. 7 No. 1), and the *Annual Report* for 1935, were published, whilst various instructional leaflets were issued.

The year 1936 was, so far as the affairs of the Institute are concerned, one of transition, with a change in the Directorship, and much of the attention of all Divisions devoted to preparations for removal into the Institute's new and permanent quarters. Incidentally, that removal has been responsible for the delay in the publication of this issue of the Institute's Annual Report. Many matters of policy and organisation, together with the appointment of men to fill vacancies on the staff, had been purposely left for decision after the new Director had taken over. The first complete

year of the writer's tenure of office, namely 1937, will see the effects of these measures, and it is both more convenient and more appropriate that a fuller treatment of the scope and development of the Institute's work should be reserved for the 1937 annual report. The present report is for that reason shorter and more objective than is customary.

I should like to take this opportunity of paying my tribute to the sterling work of my predecessor, and also of thanking all my staff, from the most senior to the most junior, for the loyal and friendly way in which they have helped me to settle down into my job.

H. J. Page

Director

APPENDIX

Botanical Division

Analysis of Correspondence, 1936

Subject	Letters received	Letters despatched
I. Budding.		
General. Advice on choice of clones. Clone Records	418	435
Training of Conductors and Pupils from Estates, etc.	5	5
Field Experiments (Estate Trials) ...	12	10
Growth of Budded Trees	9	9
Purchases and Exchanges of Budwood	12	10
	456	469
II. Tapping.		
Estate Enquiries. General	90	94
Estate Experiments. General ...	18	6
Estate Enquiries (Tapping of Budded Trees)	46	38
Estate Experiments (Tapping of Budded Trees)	158	103
Test Tapping of seedlings	6	6
	318	247
III Selection.		
Selection of Parent Trees on Estates	4	7
Latex Vessel and Bark Examinations	7	6
Isolation Gardens	21	24
Seed Germination	3	3
Seed packing	1	1
Seeds for Experimental purposes ...	6	6
	42	47
IV. General Planting Enquiries		
Information on planting operations ...	14	17
Replanting	233	238
Cover Plants	142	159
	389	414
V. Special Enquiries in connection with Rubber Assessment	26	29
VI. Planting of Experimental Areas on estates under the Rubber Regulation Scheme	578	576
VII. Apparatus	3	3
VIII. Miscellaneous	19	20
Total ...	1,831	1,805

Chemical Division

Analysis of Correspondence, 1936

Subject	Letters Received	Letters despatched
Latex	27	39
Latex Preservation	136	138
Latex Concentration	67	90
Latex—Instruments for determining D.R.C. ...	113	130
Anti-coagulants of Latex	16	16
Anti-oxidants of Latex	4	4
Coagulants	38	48
Coagulating Tanks and Pans	4	7
Rubber Preparation—General Enquiries ...	22	26
Smoked Sheet	206	252
Air-dried Sheet	1	2
Crepe Rubber	31	25
Sole Crepe	5	5
Raw Rubber Powder	3	4
Water Samples	15	15
Machinery for Rubber Manufacture ...	45	59
Smoke Houses	129	190
Vulcanisation of Rubber	53	63
Accelerators for Vulcanisation	11	12
New Uses of Rubber	21	22
Softened Rubber	1	1
Rubber Substitutes	2	2
Rubber Paving for Road Surfacing ...	7	8
Rubber Paints	3	2
Rubber Seed Oil	6	5
Rubber Oil	2	2
Patents	25	40
Orders for Chemicals, etc.	23	18
Apparatus	42	63
Miscellaneous	100	118
Total ...	1,158	1,406

Pathological Division

Analysis of Correspondence, 1936

Subject	Letters received	Letters despatched
Root Disease	155	203
Stem and Branch Disease	97	108
Leaf Disease	258	281
Fungicides and Insecticides	39	48
Tree operations	1	3
Injury by External Agents	7	10
Insect Pests	96	113
Brown Bast	10	9
Spraying and Dusting Equipment	8	11
Pathology of Buddings	1	2
Disease—general treatment	24	27
Replanting	29	31
Lightning	8	8
White ant treatment	11	13
Sulphur Dustings	9	8
Summary to questionnaire on Replanting ...	—	32
Miscellaneous	87	146
	840	1,053
Circular and Questionnaire re Cockchafer Pest		2,507
Total ...		3,560

Soils Division

Analysis of Correspondence, 1936

Subject	Letters received	Letters despatched
Cultivation—General Enquiries	13	14
"Forestry" Methods	20	20
Experiments	36	30
Cover Crops and Natural Covers—		
General Enquiries	107	125
Manuring	9	10
Eradication by Weed-Killers ...	22	30
Seeds	6	7
Manuring	352	400
Soil Conservation and drainage	15	21
Catch Crops	10	11
Replanting	280	330
Visits	41	57
Fertilisers	26	34
Soil samples	132	172
Experimental planting under the Rubber Regulation Scheme	278	321
Apparatus	5	9
Miscellaneous	23	26
Total ...	1,375	1,617

APPENDIX

Experimental Planting of Reserve Land

Summary of Allocation of Experiments as at 31st July 1937

Type of Experiment	Acreage allotted						Totals	
	F.M.S.	Johore	Kedah & Perlis	S. S. & Brunei	Kelantan	Trengganu	Without Agreements	With Agreements
A. Selection of improved planting material in continuation of previously established experimental and demonstration work	932.25	369.00	—	90.00	—	—	1,391.25	—
B. Experimental Sub-Stations								
Selection of planting material, and manuring	750.00	250.00	225.00	—	—	—	—	1,225.00
C. Methods of opening and subsequent treatment	582.30	200.00	—	—	—	—	150.00	632.30
D. Manuring Experiments								
(1) Supplementary to B	110.00	250.00	39.06	—	—	50.00	60.00	389.06
(2) Manuring on alluvial clay soil	50.00	—	—	—	—	—	—	50.00
(3) Manuring on peat soil	50.00	—	—	—	—	—	—	50.00
(4) Phosphate manuring	180.00	180.00	—	—	—	—	—	360.00
(5) Time of application of fertilisers	—	100.00	50.00	—	—	—	—	150.00
(6) Manuring on lalang land	50.00	42.00	125.00	—	—	—	—	217.00
E. Selection of improved planting material	1,318.15	260.00	100.00	175.00	60.00	25.00	—	1,938.15
F. Density of planting	100.00	300.00	—	—	—	—	—	400.00
G. Cover crops	50.00	—	100.00	—	—	—	—	150.00
H. Time of commencing tapping	—	120.00	60.00	—	—	—	—	180.00
J. Miscellaneous								
(i) Cover crops (manuring and inoculation)	110.00	—	—	—	—	—	—	110.00
Special Reserve for allocation by Rubber Research Institute of Malaya							213.05	
TOTAL AREAS WITHOUT AGREEMENTS	1,142.25	369.00	—	90.00	—	—	1,601.25	—
TOTAL AREAS UNDER AGREEMENTS	3,140.45	1,702.00	699.06	175.00	60.00	75.00	—	5,851.51
TOTAL AREAS ALLOCATED	4,282.70	2,071.00	699.06	265.00	60.00	75.00	**7,665.81**	
TOTAL AREAS PERMITTED UNDER INTERNATIONAL AGREEMENT	4,505.00	2,240.00	750.00	265.00	160.00	80.00	**8,000.00**	

SOILS DIVISION

STAFF

The Division was at full strength throughout the year, except for the services of the advisory officer, Mr. A. Moore, who was absent on home leave until 1st June, when he returned and assumed duty as an advisory officer attached to both the Chemical and the Soils Divisions.

Laboratory Work

The numbers of samples received, with the determinations made on them, were :—

	1931	1932	1933	1934	1935	1936 to Sept.
Samples received	369	336	368	304	789	850
No. of analytical determinations	2,742	3,473	3,770	2,138	3,745	7,855

There was, therefore, a very large increase over previous years in the number of samples received and in the number of analyses carried out, owing mainly to the large number of soil profiles which were examined and sampled.

This record of laboratory work refers only to the period 1st January to 23rd September, 1936, because the fire which then occurred at the Institute destroyed completely the Soils Division laboratory and offices, thus causing the cessation of analytical work until the New Buildings could be occupied.

The losses caused by the fire, apart from apparatus, chemicals and general laboratory fittings, involved laboratory and field note books, growth measurements on experimental areas, soil profile descriptions and analyses, records of leaf analyses, analytical data referring to laboratory experiments then in progress, meteorological data, a large number of papers, reprints, and pamphlets referring to soil investigations generally, as well as actual samples of soils, and leaves.

Unfortunately, many of the records were unduplicated, particularly with regard to the investigations of the Soils Chemist, Mr. Hamilton, and their destruction represents the complete loss of 'six to twelve months' work.

After the fire the staff of the Division was fully occupied, despite being unable to carry on normal laboratory work, in the following directions—the preparation of details of materials destroyed by the fire for insurance purposes, and of apparatus, chemicals and specifications of fittings for the new laboratories; the replacement, as far as possible, of samples of leaves and soils and of growth measurements destroyed by the fire, and the re-measurement of all the Soils Division blocks at the Experiment Station.

Advisory Work

In general, there was a very marked increase during the year in requests for advice both by letters and by visits, owing mainly to widened interest in the subjects of replanting and manuring.

Correspondence

An analysis of correspondence will be found appended to the Director's report, and the total numbers of letters (1,375 received, 1,617 despatched) dealt with during the year have doubled those of 1935 (715 received, 808 despatched). Most of the increase is accounted for under the headings of "manuring," "replanting," "soil samples" and "experimental planting."

Visits

Again the number of visits to estates which were made in 1936 (322) has just doubled the number during 1935 (169) and it is of interest to record that over 20 separate tours of visits were made to Johore (6), Perak (5), Kedah (3), Negri Sembilan (3), Malacca (2) and Pahang (2), the total number of visits to individual estates in the country being 322.

Lectures

During 1936, the following ten lectures were delivered by members of the Division :—

C. G. Akhurst

(1) At Teluk Anson, on 21st February, 1936, to the Lower Perak Branch, Incorporated Society of Planters, on the subject of "Replanting."

(2) At Sitiawan, on 30th June, 1936, to the Sitiawan Branch, Incorporated Society of Planters, on the subject of "Cover Plants."

R. A. Hamilton

(3) At Nilai, on 3rd April, 1936, to the Nilai District Branch, Incorporated Society of Planters, on the subject of "Notes on Tropical Soils, with special reference to Malayan Rubber Soils."

(4) At Rantau, on 26th May, 1936, to the Seremban—Rantau—Port Dickson Branch, Incorporated Society of Planters, on the subject of "Notes on Tropical Soils, with special reference to Malayan Rubber Soils."

(5) At Kajang, on 29th July, 1936, to the Kajang Branch, Incorporated Society of Planters, on the subject of "Notes on Tropical Soils, with special reference to Malayan Rubber Soils."

(6) At Taiping, on 7th August, 1936, to the Taiping District Planters' Association, on the subject of "Rubber Soils of Malaya."

(7) At Ipoh, on 5th September, 1936, to the Central Perak Planters' Association, on the subject of "Rubber Soils of Malaya."

(8) At Kuala Lumpur, on 3rd October, 1936, to the Annual Conference, Incorporated Society of Planters, on the subject of "Soil Investigations in Relation to the Cultivation of Rubber Trees in Malaya."

A. Moore

(9) At Banting, on 19th August, 1936, to the Kuala Langat District Planters' Association, on the subject of "Replanting."

(10) At Caledonia Club, on 28th December, 1936, to the Malay Peninsula Agricultural Association, on the subject of "Replanting."

COVERS

The practice of growing cover plants, both indigenous ("natural") and cultivated leguminous types, has again received some attention because of the extension of replanting work and also because of the experimental planting of certain selected jungle areas.

In all replanted areas, the establishment of leguminous covers is attempted and is regarded as an essential feature of the replanting programme. Whilst the growth of the young rubber plants is assured by means of adequate and suitable manuring, the soil itself will undergo a process of improvement as a direct effect of the covers.

Both bushes and creepers are employed, but some of the most vigorous growth is seen in areas where *Pueraria javanica* is planted. Bushes tend to establish more quickly than creepers, but more ground-weeding is required when using them. Mixtures of bushes and creepers have been tried also, resulting in the creeper (*Pueraria javanica*) taking complete charge within six months. Under these conditions, once the creeper has advanced completely over the bushes, a certain amount of "beating down" is an advantage in producing a more satisfactory incorporation of the plant residues into the soil.

From one or two results which are available it appears possible, on light sandy loam soils, for bush covers to compete very strongly against replanted rubber seedlings for the manures which are applied as part of the replanting scheme. On such sandy soils there may be a slight lateral movement of water at 12" to 18" below the surface, which will carry plant foods from the planting holes. Any bush-cover roots in the neighbourhood will develop along this line of water movement, and, if they receive this plant-food solution (derived from the manures), will rapidly grow *into* the planting hole. Such an effect has been observed in a large number of holes in a replanted area, and hence caution should be exercised in using bush legumes on replanted sandy soils.

The question of digging in covers under rubber has received too little attention in Malaya so far. The value of green plant residues when dug into poor soils is well known, and this method of treating covers is being investigated by means of field experiments.

The establishment of legumes under mature rubber still proves difficult, and should only be attempted when no types of natural covers will grow. The effect of shade from the old rubber trees appears to be a very important factor in checking the growth of any planted leguminous covers, and this cannot be overcome by manuring. Root competition must also be eliminated, but this can be done by trenching.

Fertilisers containing nitrogen, potash, and phosphates are commonly needed to produce good growths of covers, though in some replanted areas, phosphates alone have been effective.

Natural, or indigenous, covers under mature rubber continue to make headway on estates, and whilst their value is now well appreciated, it is also realised that for the rubber trees to obtain maximum benefits the covers must be supplemented by manures in most instances. Attempts at introducing indigenous covers by

means of planting seeds or cuttings have not proved very successful, and results do not justify the expenditure involved. The best growths of natural covers are achieved by cultivating those plants which appear of their own accord. It must be recorded, however, that *Hedyotis congesta* has been successfully spread on an estate by means of chickens. The seed were fed to the fowls, which were enclosed in a light movable wire pen, and by moving the pen daily small clumps of *Hedyotis congesta* have been grown, the seed having germinated successfully after passing through the bodies of the birds.

In newly-opened jungle clearings, by means of lightly burning or scorching the felled jungle, or even by leaving it unburned, much more care is now taken to preserve the young jungle plants and to allow them to regenerate as quickly as possible. A number of experiments are in progress to determine which methods of opening jungle land and controlling the covers will prove most suitable for the growth of rubber plants. During the first year of growth it is desirable to limit control methods to slashing at suitable intervals, so as to prevent shading of the rubber seedlings, and only the most undesirable types are kept out. Once the stand of covers is established, gradual eradication of less desirable types can be instituted.

Control of Natural Covers

Successful eradication of bracken and stagmoss has been achieved by methods other than those involving digging and forking, and a brief mention of the procedures actually used on certain estates is of interest.

One method employs an initial slashing and beating of the cover, followed immediately by the application in dry weather of calcium cyanamide, broadcast at the rate of 3 cwts. per acre. The initial slashing and beating cost about $5/- per acre, and the calcium cyanamide about $11/- per acre. The immediate result is a burning and scorching of the bracken and stagmoss. (Note: desirable types of natural covers should not be slashed and beaten, and should be avoided in broadcasting the cyanamide). Regeneration of the plants is extremely slow, so that a cheap round of hand-pulling of any young shoots of bracken and stagmoss, about six months after the initial slashing, allows the area to go on to a normal weeding basis in the future.

Finally, there is a residual manuring effect from the nitrogen in the cyanamide which improves the foliage of the rubber trees and the growth of any of the better types of natural covers which appear. This is somewhat more slowly available than the nitrogen in ammonium sulphate, but the latter is ineffective in suppressing the weeds.

The other method of eradication depends entirely on beating the plants (bracken and stagmoss) with rotans about 7 ft. or 8 ft. long. The beating must be thorough, so that the broken plants are pressed quite close to the ground, and a second beating after six months is normally required. The cost of the two beatings is about $4/- per acre, and permits the area to continue on a normal weeding basis, with complete eradication of the bracken.

It will be seen that there is a certain similarity in both treatments, but that one depends on the phytocidal effect of calcium cyanamide, in addition to the beating procedure. Both have the advantage of avoiding any soil disturbance through digging out the covers.

Replanting

Although a considerable amount of replanting was undertaken in 1936 in Malaya, the total acreage which has so far been replanted under the Rubber Regulation Scheme falls far short of the permissible 20% of the total planted land. Furthermore, all except a minute fraction of the acreage of rubber which has been cut out and replanted belongs to estates which are classified as other than small-holdings. In other words, whilst small-holdings account for nearly half the rubber land in Malaya, they have not yet commenced to replant their poor rubber, and most large estates are only doing tentative programmes.

Much of the old rubber in this country (*i.e.* over 25 years of age) is steadily deteriorating year by year. Manuring will rarely do more than arrest such deterioration and maintain yields at their present level. By replanting, a new full stand of healthy trees is obtained, high yields are more or less guaranteed by the new proved planting material which is available, manuring will ensure satisfactory growth of the rubber plants, and leguminous covers will improve the general condition of the soil.

The economics of the situation turn entirely on questions of relative yields of the old stand and the new stand of rubber trees. The price of rubber only affects the situation if it has fallen very considerably by the time the new trees come into tapping. To forecast the price of a commodity seven years ahead is an impossibility, and therefore this aspect of the position cannot be taken into account. If rubber now yielding 400 lb. per acre per annum is replanted, then, after making allowance for a liberal manuring programme and without expecting unduly high yields from the new trees, one can anticipate (*R.R.I. Journal* Vol. 6, no. 2, p. 121) that after 12 or 13 years the capital cost of replanting will have been covered and the amount spent on fertilisers will have been no more than that required for manuring the old stand of rubber over the same period. But the very great advantage in favour of replanting

is that at the end of the period in question the trees are young and healthy and capable of yielding about three times the rate at which old rubber trees could have been expected to yield, with the prospect of a long period of years over which these yields can be expected to continue. And it must be accepted that, irrespective of whether prices are slumping or booming, a high-yielding estate is always in a much sounder position than a low-yielding one.

The evidence from replanting which is to be seen in all parts of the country is confirming that manures must be used, and at the start a complete type of fertiliser is necessary. A number of trials have been instigated by the Soils Division, and the height measurements recorded after the first six months of growth give a mean height between 36 inches and 40 inches, the averages being computed from at least 50 or 100 trees per plot. There appears to have been no advantage so far in using an organic animal meal fertiliser as against the cheaper forms of mixed or compound "complete" chemical fertilisers.

In order to determine to what extent replanting can be successfully carried out on heavily lateritic soils (*i.e.* compact laterite gravel within 12 inches of the surface) an experiment has been laid down, in conjunction with Imperial Chemical Industries Ltd., in which the effect of small charges (2 oz. to 3 oz.) of dynamite are being tried. Replanting on such soils normally could only be undertaken if large (3′ x 3′) planting holes were prepared and filled with good top soil and the cost of such work is more than the cost of the blasting procedure.

The charges are exploded in the laterite layer at the new planting point and the planting hole is then dug. The explosion makes the preparation of the hole comparatively easy and it is hoped that the sub-soil of laterite will also be effectively fissured, with a corresponding benefit to future root development.

Comprehensive manuring experiments on several replanted areas have been commenced with the object of comparing fertilisers of different compositions on different soils, and valuable results are expected from these trials.

From results obtained in Sumatra and from those in Malaya, young rubber plants appear to benefit most from phosphate manures. Most Malayan soils on analysis show very small amounts of available phosphates, but usually have adequate supplies of potash. Nitrogen, on the other hand, is very quickly lost under the local conditions of heat and rainfall and rapid plant growth.

For these reasons it can be argued that the most suitable fertiliser for young replanted rubber, at the commencement of its growth, is one containing phosphates, nitrogen and potash in that descending order of magnitude.

On some soils, of course, potash manuring will assume more importance. For example, on a peat soil, very little nitrogen, if any, is required, but potash and phosphate will be deficient. On sandy soils, whilst all plant foods are likely to be present only in small quantities, extra amounts of potash will be required for satisfactory plant growth.

On coastal clay soils the indications are that manurial deficiencies are likely to be very slight, and that in most instances the attainment of good growth will be chiefly dependent upon drainage conditions in the soil.

It must be emphasized that in all cases of manuring of young rubber, fertiliser balance is a factor which must not be ignored. To apply an excess of one plant food, merely because it is cheap or in order to be on the "safe side," may alter the plant-food balance to such an extent that the rate of growth is slowed.

Whilst replanting results to-date are good, the criterion of judgment has of necessity been growth measurements, but the real test will come when the trees come into tapping and yield figures are available, and final judgment upon replanting must be reserved until then.

Manuring

General interest in the manuring of mature rubber trees has been much greater and is due to a steadily growing appreciation by managers and directors of estates of the improvements which are possible by the use of suitable fertilisers. Experimental evidence is still very incomplete, and there is a vast amount of detailed investigation waiting to be done.

An interesting report was made by Haines and Guest of Dunlop Plantations, Ltd. and Imperial Chemical Industries, Ltd., respectively, upon a number of experiments on mature rubber, with modern statistical lay-outs, and their general conclusion was that nitrogen was the main requirement of the rubber trees, and that other plant foods such as potash and phosphate were required only on certain exceptional soils in this country.

The evidence from other manuring experiments is beginning to show, however, that cases where the rubber trees benefit by mineral manuring are less exceptional than indicated above, particularly with regard to the use of phosphates, and that "fertiliser balance" is an aspect of rubber tree manuring which must be considered, although this applies especially to young rubber. At the moment, however, it is not possible to make any well-substantiated generalisations on this point.

Manuring of coastal soils is a subject on which there is extremely little knowledge, and a series of experiments were started during

1936 in the Kuala Selangor district for the purpose of examining the effects of manures on rubber trees growing in alluvial clay and peaty soils. The few results from older experiments that are available all point to a lack of effect when coastal clays are manured, and it may prove that, given adequate and suitable drainage from the time of planting, rubber trees in these soils do not require artificial fertilisers, or only in very small amounts.

Experiment Station

Girth measurements were recorded on all plots, tapping was continued in Blocks 6, 7, 8, 9 and 11, and new areas were opened for tapping in Block 23.

The main interest still lies in the growth and yield records from the manuring experiment in Block 6, and these will be fully dealt with in the next number of the *Journal* (Vol. 8, no. 1). It is perhaps desirable to detail the summarised results and conclusions given in the above article :—

1. Measurements of girth, yield and bark thickness are presented relating to young seedling rubber trees planted on virgin jungle soil (sandy quartzite type) which have been manured experimentally.

2. Cattle manure and complete inorganic manure have produced growth which, on girth measurements, is just significantly greater than that of trees which received no manure, nitrogen only, or nitrogen + phosphate.

   Trees manured with phosphate + potash are just significantly larger than those receiving nitrogen alone or nitrogen + phosphate.

3. Yield data for the first two years of tapping show that the complete inorganic fertiliser has produced a very significant increase over any other fertiliser and is the only fertiliser which has affected the yields significantly.

4. Bark renewal has not yet been influenced by the fertiliser treatments.

5. Girth measurements of young manured seedling rubber trees do not necessarily reflect their relative yielding capacity.

6. Correct balance of plant foods in a fertiliser, in relation to soil type, is important when the manuring of young rubber is being considered, and on soil similar to this sandy quartzite the value of potash manures in particular, used in conjunction with nitrogen, is emphasized.

7. In order that the amount of growth and the level of yield of the rubber trees in this experiment may be compared with similar information for other areas, the relevant data are summarised below, as averages for the whole area :—

Planting Material	Seedling stumps from a high-yielding area
Age of trees	8 years and 2 months
Average girth at 1 foot	34.5 inches
Average girth at 3 feet	28.9 inches
Method of tapping	Alternate-daily, ½ V-cut and ½-spiral cut
Yield per acre, 1st year of tapping (6 yrs. 2 months to 7 yrs. 2 months)	303 lb.
Yield per acre, 2nd year of tapping (7 yrs. 2 months to 8 yrs. 2 months)	458 lb.
Thickness of renewed bark, after 12 months renewal	7.86 mm.
Thickness of renewed bark, after 22 months renewal	8.37 mm.

In Block 11, where plots of uncontrolled jungle growths are maintained, the growth still follows the trend in previous years—unslashed *belukar* has considerably retarded the trees, compared with clean-weeded and slashed treatments. The yields which have been obtained to date have one striking feature—the yield per acre (18 months tapping) in the clean-weeded areas is approximately double that in the slashed and unslashed sections, and this can be attributed to the greater number of trees per acre which are tapped (about 150% more).

Comparison of yields on yield per tree basis show that the wide-planted sections (22′ × 22′) give about 50% more than the close-planted sections (22′ × 11′). The yields under the different cover treatments do not vary greatly, but they tend to fall in line with the girth measurements, *i.e.* the unslashed sections are the least well-grown and give the poorest yields.

Experiments in Blocks 19 and 25, comparing the effects of different types of cover and treatments of cover upon young rubber, all emphasize the retarding effect of grasses on growth. The trees in the clean-weeded plots always have the greatest girths.

On hill land, Block 27, where contour planting on terraces was carried out, the growths of young rubber under leguminous bushes

and leguminous creepers as well as under natural bush covers with varying degrees of control, have been compared. At 15 months of age, height measurements revealed no significant differences due to the different covers, though it must be remembered that all terraces (48 inches wide) are kept clean-weeded. On plots where natural covers received a minimum amount of control, there was a suggestion that a slight retardation of the young rubber was occurring, due to overshading.

The manuring experiment in Block 31 on budded rubber is progressing satisfactorily after a somewhat slow start, and the area will be budgrafted in 1937.

Manuring experiments were laid down in Block 23 on backward areas of rubber trees which previously had been intercropped with pineapple, tapioca and coffee.

A general scheme of manuring for backward areas on the Experiment Station was drawn up, and manures will be applied in 1937.

Experimental Planting

The scheme of planting for experimental purposes on reserve jungle land threw a great deal of additional work on the Soils Division, and altogether about 130 inspections of reserve land have been made. In conjunction with the Botanical Division, experiments have been devised for over 40 of these areas, and in 16 instances the experimental plots have been planted. The balance of the experimental areas will be planted during 1937 or 1938 (see Appendix to the report of the Director).

Laboratory Research Work

A considerable expansion of laboratory work took place during the year, and much of this was connected with research problems. During the previous two years, owing to changes in the staff and to home leave arrangements, research work was badly interrupted, but in 1936, with normal conditions, it was possible to resume work which had previously just been started and to commence new lines of attack on various problems.

The fire in September, however, destroyed considerable data which had been obtained, and it is not possible to report any definite results from some lines of work.

Soil profile studies on virgin jungle soils and on cultivated rubber soils produced an extensive series of analyses of the soil samples obtained from the different profiles, and a preliminary article by the Soils Chemist appeared in the June number of the *Journal*, in which a summary of the results to that date was given. Since then the

number of profiles examined and sampled has greatly increased and the soils are awaiting analysis.

An examination of the possible value of rubber leaf analysis, as an aid to determining plant food deficiencies in the soil and the manurial requirements of rubber trees, was commenced and the early results were distinctly promising. The completed analyses will be used in classifying and comparing the different soil types in Malaya on which rubber trees are grown, with the ultimate object of assessing their relative values for the cultivation of the rubber plant. This work will be extended considerably in 1937, using leaf material from manuring experiments which are well established and yielding definite results.

Preliminary work on the fixation and availability of phosphates in soils with reference to the manuring of rubber trees was commenced, and the results obtained shewed in general a low phosphate availability with rapid fixation of added phosphates, for most soil types. Trials were made using rice seedlings in a modified Neubauer method for determining the availability of plant foods in soils.

Nitrification studies on local soils were also commenced, but had not proceeded beyond the preliminary stages, and merely gave a general indication that very little nitrification occurs normally.

The possibility of loss of ammonia, from mixtures of different fertilisers in which ammonium sulphate is included, was investigated and reported on in the *Journal,* Vol. 7, p. 105. The conclusions arrived at were that certain rock phosphates (Gafsa and Cheribon), when mixed with sulphate of ammonia, tended to decompose the ammonium compound and cause loss of nitrogen, as gaseous ammonia. Hence, for these particular forms of phosphate, a separate application in the soil is recommended about one week after any ammonium compound is applied.

Publications

"Notes on Tropical Soils with Special Reference to Malayan Soils for Rubber Cultivation" by R. A. Hamilton,

R.R.I. Journal, Vol. 7, no. 1, p. 27.

"A Note on the Mixing of Fertilisers" by C. G. Akhurst,

R.R.I. Journal, Vol. 7, no. 1, p. 105.

Summary of Rainfall at the R.R.I. Experiment Station

	1932	1933	1934	1935	1936
			inches.		
January ...	4.92	6.06	11.01	5.46	4.73
February ...	8.98	6.69	5.85	3.85	6.45
March ...	10.51	19.17	13.36	6.69	12.69
April ...	6.19	16.35	12.01	7.04	7.04
May ...	8.67	9.41	4.55	5.01	13.57
June ...	2.40	2.76	6.05	5.74	7.18
July ...	2.77	4.62	5.62	2.35	0.66
August ...	12.73	4.65	7.63	11.51	4.01
September ...	8.31	10.16	9.56	5.15	7.66
October ...	17.29	6.56	10.00	9.88	11.12
November ...	11.76	11.40	15.82	12.16	9.34
December ...	12.74	14.75	3.35	18.12	8.57
Total ...	107.27	118.58	104.81	92.96	93.02

C. G. AKHURST

Senior Soils Chemist

ANNUAL REPORT

BOTANICAL DIVISION

The work of the Division has been continued on the same lines as previously, further work on new aspects of certain subjects of investigation has been initiated and considerable progress has been made in extending the scope of the more advanced investigations by means of large-scale field experiments.

Staff

Until 11th March 1936 Mr. C. C. T. Sharp continued to act as Senior Botanist, in charge of the Division. Mr. C. E. T. Mann returned from leave and resumed duty on 12th March. Dr. E. D. C. Baptist arrived in Malaya on 20th March and assumed the appointment of Botanist, filling the vacancy created by the resignation of Mr. H. Gunnery in July 1935.

Although provision had been made for the appointment of an additional officer to undertake advisory work and to assist with the development of new experimental planting, considerable difficulty was experienced in the selection of a candidate with the qualifications and experience desired. The post remained vacant at the end of the year.

Reports on Investigations

It has been customary in previous reports of this Division to publish somewhat detailed summaries of the data with notes on the principal results of each investigation. This procedure was felt to be desirable in view of the long-period character of the majority of botanical studies on rubber; the *Annual Report* provided a convenient medium for placing results on record in preference to the publication of separate progress reports for each investigation.

A good deal of the work has now reached the stage when separate publication of complete descriptions of the experiments with results to date is necessary. In the present report, therefore, summaries of experimental data have been omitted as far as possible and observations are confined to a description of the principal results so far obtained.

I. Vegetative Propagation

(1) Technique of Budding Operations

Methods of budding or budgrafting may now be considered to have become standardised. The study of modifications of standard

methods in their application on difficult stock material has been completed and the results published.

(2) Growth and Yield of Budded Trees

The study of the growth of budded trees of the principal clones used in commercial planting has been continued on the Experiment Station and on estates.

In the first clone trial experiments established at Sungei Buloh, regular tapping commenced on 1st January 1936. All trees that had attained a girth of 18 inches at a height of 40 inches from the union were brought into tapping. The standard procedure adopted is to commence tapping at a height of 40 inches from the union with a left-to-right spiral cut with a slope of 30 degrees on half the circumference. Tapping is alternate-daily and the rate of bark consumption does not exceed ¾-inch per tapping month.

The principal results are summarised in Table I.

The experimental blocks from which the data given in Table I have been obtained, are planted on the light, sandy soil on the flat area of the Experiment Station. Growth on the whole of this area is below the average growth standard obtained by compilation from a large number of records from similar material on a wide range of soils on estates.

At the same time, the figures of percentage of tappable trees in the different blocks provide a good index of the relative vigour of growth of the different clones. Clone Pilmoor B.84 is outstanding in vigour and clones Tjirandji 1 and Prang Besar 186 are also very satisfactory.

The records from Block 17A are of particular interest as they illustrate the relative vigour of growth of buddings and seedlings. Although the seedlings were planted six months later than the stocks of the buddings, at six years from the date of planting 79 per cent of the seedlings had reached tappable size as compared with 51 per cent of the buddings of the strongest clone, Tjirandji 1, and only 9 per cent of the buddings of the weakest grower, A.V.R.O.S. 183. Early selective thinning of the seedling trees would have reduced competition and a larger proportion of buddings would have reached tappable size. Thinning was not done, however, as we wished to retain an area comparable with similar plantings on many estates where test-tapping and thinning of seedlings which should have been done in the years 1933—34 was not carried out and consequently the growth of buddings has been severely restricted. The actual yields of the budded trees, except in clone A.V.R.O.S. 50, are at least double those of the seedlings.

TABLE I. *Summary of Yield Records of Budded Trees in the first Tapping Year.*

Experimental Block No.	Acreage	Description of Block	Clone	Tappable Trees Percentage	YIELD	
					Gm. per Tree per Tapping	Pounds per Tree per Year
5	40	Planted with budded stumps in November 1929 in plots of single clones. 108 trees per acre.	A.V.R.O.S. 152 ...	59	10.5	3.7
			A.V.R.O.S. 49 ...	63	13.0	4.6
			P.B. 23 ...	57	14.0	4.9
			P.B. 186 ...	74	13.9	4.9
		Age 6 to 7 years.	B.D. 5 ...	18	11.7	4.1
			Tjir. 1 ...	76	21.0	7.4
			Pilmoor A. 44 ...	75	23.0	8.1
			Pilmoor B. 84 ...	86	16.4	5.8
			A.V.R.O.S. 50 ...	64	12.7	4.5
17A	10	Planted October 1929. Budded December 1930. Interplanted April 1930 with seedlings. 180 trees per acre in equal proportions of buddings and seedlings.	Tjir. 1 ...	51	19.1	6.7
			Tjir. 16 ...	16	18.1	6.4
			A.V.R.O.S. 183 ...	9	18.1	6.4
			A.V.R.O.S. 185 ...	18	22.8	8.0
			Glenshiel 1 ...	26	18.1	6.4
			A.V.R.O.S. 50 ...	10	8.7	3.1
		Age—Buddings 5—6 years. Seedlings 5¾—6¾ years.	Seedlings (Unselected) ...	79	9.1	3.2
21	25	Planted December 1929. Budded October 1931. 90 trees per acre.	Tjir. 16 ...	10	17.9	6.3
			A.V.R.O.S. 71 ...	47	10.1	3.6
			B.D. 10 ...	40	10.0	3.5
		Age 4¼ to 5¼ years.	S.R. 9 ...	9	8.1	2.9
		(Reckoned from date of budding)	A.V.R.O.S. 256 ...	21	6.6	2.3
			Ct. 88 ...	40	12.7	4.5
			A.V.R.O.S. 50 ...	22	8.2	2.9

The data from Block 21 further illustrate the wide differences in vigour between different clones. Competition between the more vigorous and the weaker clones may be similar to that between seedlings and buddings and it is noteworthy that clone Tjirandji 16, which is by far the highest yielder, is one of the weakest growers. Competition with more vigorous but less productive clones will prevent such a clone from reaching the high level of yield of which it is capable.

These early records lend further support to the recommendation that buddings should be planted in blocks of single clones in order to ensure the best conditions for development and future production. They indicate also that the early crops from mixed areas of buddings and seedlings, in which systematic thinning has not been done from an early age, are likely to be disappointing and will provide no useful criterion of the true value of budded trees.

With regard to the relative merits of the clones included in these experiments, from the standpoint of yield, clones Tjirandji 1 and 16, A.V.R.O.S. 183 and 185, Pilmoor A.44 and B.84, Prang Besar 23 and 186, Glenshiel 1 and Ct.88 have given the highest yields. These records confirm very closely the classification of the clones based on the records of the original tests on the first buddings established. Further observations on the secondary characters of the clones also confirm previous observations. Despite their high yields unfavourable secondary characters such as very weak growth, A.V.R.O.S. 183; leaning trunks, A.V.R.O.S. 185; fluted, uneven tapping surface, Pilmoor A.44; rule a number of the highest-yielding clones out of consideration for commercial planting.

Under the conditions of test on a soil of less than average fertility the results obtained so far have been of considerable value in the selection of the clones likely to prove most satisfactory for use in replanting. Since, in general, the soil in areas to be replanted is below average fertility, vigour of growth is a most important consideration in the selection of planting material. Three of the most promising clones for use in replanted areas on inland soils are Pilmoor B.84, Tjirandji 1 and Prang Besar 186.

The detailed study of different clones on the Experiment Station has been supplemented by observations on estates. These observations indicate that environmental conditions, of which soil conditions are probably of the greatest importance, may have a considerable influence on the development of different clones. For example, Clone B.D. 5, one of the oldest-established clones with an excellent yield record, has made very slow growth on the Experiment Station, and this is reflected in its low yield in Block 5 (Table I). On estates on soils of similar geological origin the same experience is recorded, but on the alluvial clay soils of the coastal districts growth is generally much more satisfactory. Similar observations apply, but to a less

marked degree, to clones Glenshiel 1, Sabrang 24, Tjirandji 16 and S. R. 9 among the better class clones. On the other hand, certain clones, *e.g.* Tjirandji 1, Prang Besar 86 and 186 and A.V.R.O.S. 49, appear to grow well on a wide range of soils and are apparently much less sensitive to differences in environment. Clone Pilmoor B. 84 would appear to be particularly adaptable, to judge from the published results of tests carried out on young buddings of this clone in Sumatra and Java. These confirm very closely the results obtained in Malaya and it is noteworthy that in both Java and Sumatra this clone is recommended for extensive use in replanting.

The influence of density of planting on growth of buddings has been further studied in the experiment with clone A.V.R.O.S. 50.

TABLE II. *Density of Planting. Summary of Growth Records. Clone A.V.R.O.S. 50. Planted as Budded Stumps Nov. 1930.*

No. of Trees per acre	Mean Girth in inches at age of :—				
	2 years	3 years	4 years	5 years	6 years
48	4.8	8.0	12.1	16.4	19.3
108	5.1	8.3	12.1	16.3	18.7
125	5.1	8.2	12.1	15.5	18.1
222	4.9	7.8	11.5	14.8	17.1
302	5.1	8.2	11.7	14.2	15.9
435	5.2	8.1	11.1	13.2	14.7
General Mean	5.0	8.1	11.8	15.0	17.3

The records show that there was no significant difference in rate of growth at different densities up to the end of the third year; at the end of the fourth year the differences were extremely small, except for the plots planted at 435 trees per acre. From the fourth year onwards the effects of overcrowding on growth have become marked in proportion to the density of planting.

(3) RELATIONSHIP BETWEEN SCION AND STOCK IN BUDDINGS.

Previous work has shown that the early rate of growth of young buddings bears a close relationship to the vigour of the stocks when budding is done on stocks 12 to 18 months old. On older stocks over two years of age, this relationship is much less marked, probably because the vigour of the weaker stocks at this age is more than sufficient to support the maximum growth of which the scions are

capable. The stocks used in these experiments were unselected seedlings of mixed origin.

Further experiments on young stocks grown from illegitimate seeds of a number of different clones confirm that the rate of growth of the young buddings is closely related to the vigour of the seedling stocks within each clonal family. At the same time there are indications that differences in rate of growth of the buddings of the same clone made on stocks of different families of clonal seedlings may not be entirely related to stock vigour. For example, buddings of Pilmoor B. 84 made on seedling stocks derived from illegitimate seedlings of clones A. 44 and P.B. 20 gave the following figures: girth of seedling stocks, not budded, A. 44—8.9 inches, P.B. 20—9.1 inches; girth of buddings of B. 84 on A. 44 stocks—5.6 inches, on P.B. 20 stocks—7.1 inches. The difference in the rate of growth of the buddings appears greater than can be accounted for by the small difference in the vigour of the stocks.

Additional experiments on this subject are in progress and families of clonal seedlings of Tjirandji 1, Pilmoor B. 84, Prang Besar 23 and A.V.R.O.S. 256 have been budded with Clones B. 84, D. 65, Prang Besar 23, Glenshiel 1 and Tjirandji 1. Measurements taken at the time of budding disclosed no significant differences in the growth of the different seedling families.

Families of seedlings of clones A.V.R.O.S. 49, 50, 152, 256, B.D. 5 and 10, S.R. 9, Tjirandji 1 and Pilmoor A. 44 have been established for detailed study of growth, particularly the development of root systems, in relation to the general problem of stock influence in Hevea.

II. Tapping

The development of experimental work on tapping of mature rubber is restricted by the circumstance that the Institute possesses no fully-mature areas. Attempts to overcome this difficulty by collaboration with estates have met with some success and we wish to express our indebtedness to the many estate managers who have given such valued assistance in the past. It must be admitted, however, that it has frequently happened that experiments which have been started and carried on for a period have been abandoned, for reasons over which we have no control, before results of any real value can be obtained from them. The increasing complexity of the design of modern field experiments, which is necessary to ensure the requisite degree of reliability in the conclusions drawn from them, requires a closer degree of control and supervision than is generally possible on an estate. The results obtained from a few experiments on mature areas for which special provision has been made to ensure strict control and continuity of the work, suggest that some of

the most widely accepted beliefs on the principles of tapping require careful re-investigation.

Tapping Experiments on Mature Trees (Seedlings)

Investigations of Economic Tapping Systems. Experiment on 7th Mile Estate.

The yields in pounds of dry rubber obtained during the first half of the fourth year of this experiment are set out in Table III.

Table III. *Tapping Experiment on Seventh Mile Estate. Yields for the period June-November 1936 in pounds per acre.*

Tapping System	Period		Yield of First-Grade Rubber		Yield of Scrap		Total Yield of Rubber	
	Tapping Mths.	Rest Mths.	Lb.	Per cent of Control	Lb.	Per cent of First-grade	Lb.	Per cent of Control
A B C	6	3	265.8	83.1	26.7	10.0	292.5	83.0
A B C	10	5	261.9	81.9	24.4	9.3	286.3	81.3
A B C	14	7	249.9	78.1	22.7	9.1	272.6	77.4
Sunderland	3	3	226.7	70.9	30.1	13.3	256.8	72.9
Sunderland	5	5	241.3	75.4	31.3	13.0	272.6	77.4
Sunderland	7	7	233.2	72.9	34.6	14.8	267.8	76.0
Double Four A.B.C.D.	12	4	241.7	75.6	34.4	14.2	276.1	78.4
Control (A.D.)	Cont.	Nil	319.9	100.0	32.3	10.1	352.2	100.0

Note 1—Sunderland Systems. Two cuts on opposite sides of the tree tapped every third day with resting periods equal to the tapping periods.

Note 2—Double-four A.B.C.D. Two cuts on opposite sides of the tree tapped every fourth day for 12 months and rested for 4 months. For the first 28 months no periods of rest were included.

Except for the double-four plots there is a general tendency for the yields to increase slowly compared with the control, this increase being more marked in the Sunderland system plots than in the A.B.C. plots No appreciable effect of rest on the yields of the double-four plots has yet been observed.

Measurements of the thickness of the three-years-old renewed bark were taken in September, and full details will be published in the *Journal*. It was observed that the rate of renewal in the double-cut systems was higher than that of the control above the tapping

cuts and lower below the tapping cuts. It could not be shown that the rate of renewal was higher than the control in the A.B.C. plots, and in no case is there any evidence to show that resting the trees has had any effect so far on the rate of bark renewal.

ESTATE EXPERIMENTS

Further results from three experiments carried out on estates in co-operation with the Division are given below.

Experiment 1. Double-four A.B.C. and A.D., A.B.C. The trees are over 30 years old and planted on heavy coastal clay soil with a high water-table. The experiment covers an area of over 300 acres, but the plots are not replicated. A simultaneous change-over of the tapping cut has been abandoned for some years and the cuts are now at varying heights. The yield for the first year of the double-four A.B.C. fields was equal to 102.7 per cent. of the A.D., A.B.C. with a saving in tapping costs of 17.4 per cent.

Experiment 2. Double-four without rest and alternate-daily without rest. This experiment is set up on 32 acres of low-yielding 17-year-old trees on undulating land with a clay-laterite soil. At the end of the first year the yield of the double-four plots was equal to 75 per cent of that of the A.D. plots. A big advantage in the height of the tapping cuts lies with the A.D. plots, and if the yield figures are corrected for height of cut according to Grantham's data a loss of crop of only 5 per cent for the double-four plots would be recorded. Although the actual loss in crop on the double-four plots amounted to 25 per cent the increase in tapping cost per pound was only 6 per cent.

Experiment 3. In May 1932 the tapping system in a field 14 years old was changed from alternate-daily to the Sunderland system with two half-circumference cuts on opposite sides of the tree tapped third-daily for six months and rested for six months. Compared with the mean yield for the period May 1930 to April 1932, the yields for the first four years of the Sunderland system of tapping have been equal to 70, 85, 104 and 113 per cent of the A.D. tapping. During the same period the saving in tapping costs has been, 18, 21, 43 and 48 per cent. It is probable that in this case the maximum yield of the experimental area had not been reached by the fourteenth year, when the change to the Sunderland system was made, and both the yields and the saving in tapping costs may therefore be greatly exaggerated.

Tapping on the Full Circumference of the Tree

A small-scale experiment to compare tapping on the full circumference of the tree with the normal system of tapping on half-circumference alternate-daily was commenced in August 1935 on seedling trees seven years of age. (Block 6, R.R.J. Experiment Station). The

different tapping systems employed are described and the results obtained to the end of December 1936 are summarised below.

	Position of Tapping Cuts	Frequency of Tapping	Yield in lb. per Tree (17 months)	Yield as percentage of 4
1.	Two left-to-right spiral cuts on half-circumference. Upper cut opened at height of 40 inches; Lower cut opened at height of 20 inches on opposite panel	Alternate-daily 3 months tapping 3 months rest	5.4	92
2.	As in 1 above	Every 4th day. "Double-four" No rest.	6.6	112
3.	Left-to-right spiral cut on full circumference. Opened at height of 30 inches.	Every 4th day. No rest.	7.1	120
4.	Single left-to-right spiral cut on half-circumference. Even numbered trees opened at 40 inches; Odd numbered trees opened at 20 inches.	Alternate-daily No rest.	5.9	100

All tapping heights are measured from ground level to the lowest point of the tapping cut. Bark consumption is controlled so that the total consumption measured in vertical units, is the same for all groups.

The yields obtained on systems 2 and 3 have risen steadily in relation to the control from the commencement of the experiment, despite the fact that the mean height of tapping remains at a higher level in the double-cut and full-spiral systems. The results to-date suggest that it may be possible to increase with advantage the severity of the tapping operation provided that an adequate rest period is given between tappings. It yet remains to be shown how the rate and quality of bark renewal are affected by the systems of tapping on the full circumference of the tree.

Comparison of left-to-right Spiral and 'V'-cuts on half-circumference

Experiments have been continued on a small group of trees in the Lake Gardens and on an area of 40 acres of young seedling-rubber trees on the Experiment Station (Block 6, Manuring Experiment. Planted October 1928). The results of the two series of experiments show that during the first tapping year the yields on the half-spiral system are approximately 7 per cent higher than on the 'V' system of tapping on half-circumference. In the second tapping year the difference in yield on the two systems is not significant. This is in accordance with the results of previous experiments. The advantage of the half-spiral cut on young trees lies mainly in the greater ease and rapidity of tapping and it is thus possible to increase

the size of the task. On budded trees the half-spiral cut is generally to be preferred.

Tapping Experiments on Budded Trees

Tapping of Mature Budded Trees

The tapping experiments on budded trees established in 1924 on Pilmoor Estate by research officers of the Rubber Growers' Association have been continued as in previous years. These experiments have been in progress since January 1928 and results have been regularly summarised in the Annual Reports of past years.

In December 1936 tapping of the second panel, opened at a height of 40 inches from the union in January 1933, was completed. Of the 21 clones originally planted two clones, B. 84 and D. 65, are of outstanding value and the principal records for these clones are given below in order to illustrate the course of development and yield of budded trees of the type now recommended for commercial planting.

	Clone B. 84				Clone D. 65			
Year	1933	1934	1935	1936	1933	1934	1935	1936
Year of Age	9th	10th	11th	12th	9th	10th	11th	12th
Mean girth in inches at 40 inches from union ...	33.1	36.0	37.6	38.9	33.8	36.4	37.3	39.2
Mean yield in pounds per tree per year	15.9	18.5	19.2	21.5	20.0	26.0	23.2	23.0
Mean dry-rubber-content of latex per cent	36.6	38.0	38.2	37.8	32.7	32.8	31.0	36.4

The figures summarised above are sufficient to illustrate the satisfactory performance of two clones which may be regarded as fairly representative of the high-yielding clones that are now available for commercial planting. Except for a short period of three months rest from February to April 1930, all trees have been tapped alternate-daily without rest since April 1929. During 1935 and 1936 tapping was on renewed bark and on the lowest section of the bark of the scion immediately above the level of the union.

The detailed results covering a period of 10 years study from 1927 to 1937 are now being prepared for separate publication.

Influence of Tapping Height on Yield of Budded Trees

A preliminary experiment on buddings of two clones of moderate yielding capacity has shown that the increase in yield with reduction

in height of tapping is relatively small in comparison with the marked increase in the yield of seedling trees that normally occurs as the tapping cut approaches the base of the tree. The relationship between yields at different tapping heights, expressed as percentages of the yield obtained at the lowest level, is shown. The experiment has been in progress for four years; the buddings are now 12 years of age and have shown very little increase in annual yield over the period of the experiment.

Relative Yields at Different Tapping Levels

Tapping Height in inches from union :—	10 to union	20—10	30—20	40—30
Clone B. 50 ...	100	85	79	74
Clone B. 95 ...	100	91	95	72
*Seedlings ...	100	75	68	54

* *The comparative figures for seedlings are obtained from the records of earlier experiments.*

A further experiment on budded trees of the nine clones included in the first clone trial experiment on the Experiment Station (Block 5) has been in progress for two years; the results are given below.

Comparison of Yields at different Tapping Levels

Clone	1st year :—Age 5 to 6 years			2nd year :—Age 6 to 7 years		
	Yield in pounds per Tree at height		Percentage	Yield in pounds per Tree at height		Percentage
	20 to 12 ins.	40 to 32 ins.		12 to 4 ins.	32 to 24 ins.	
	(a)	(b)	b/a	(a)	(b)	b/a
A.V.R.O.S. 152 ...	3.5	2.8	80	4.2	4.8	114
A.V.R.O.S. 49 ...	4.0	3.5	88	5.7	4.8	84
P.B. 23 ...	5.4	4.5	82	7.0	6.0	86
P.B. 186 ...	5.2	4.5	85	7.2	6.3	88
B.D. 5 ...	3.4	2.8	83	4.1	3.9	95
Tjir. 1 ...	6.1	6.2	102	8.8	9.0	102
Pil. A. 44 ...	7.2	6.3	87	6.5	7.5	116
Pil. B. 84 ...	4.5	4.8	106	7.4	7.0	93
A.V.R.O.S. 50 ...	3.1	3.0	97	5.9	5.2	88
* Seedlings (1 year older than buddings) ...	4.1	2.2	54	5.6	3.8	68

* *The records for seedling trees are taken from another experiment (Block 6) but are included here to illustrate the marked difference between buddings and seedlings in their response to changes in the height of tapping.*

The results to-date confirm those from the preliminary experiment and further illustrate that there may be considerable differences in the behaviour of different clones in their responses to tapping.

In general, the results indicate that there is a tendency for yields at the higher tapping level to increase rather more rapidly than those at the lower level. This suggests that the union between scion and stock may influence the flow of latex to the tapping cut at low levels. In clones A.V.R.O.S. 152 and Pilmoor A. 44 the influence of the union appears to be most marked. In clones A.V.R.O.S. 49, Prang Besar 23 and 186 and A.V.R.O.S. 50 the influence of the union is less apparent. Clone B. 84 is interesting in that the yield at the lower tapping level has increased more rapidly than the yield at the higher level, despite the fact that the lower tapping cut is now closely approaching the union. The buddings of this clone make excellent unions with their stocks; the trunks taper smoothly at low levels and with the heavy development of cork characteristic of the bark of this clone it is frequently difficult to distinguish the line of union of scion and stock. It is possible that the apparently more intimate nature of the union may have some bearing on the yield at low levels. Clone Tjirandji 1, the highest-yielding clone under test, has given practically the same yield at both tapping levels over the whole period.

In comparing the actual yields of buddings and seedlings it should be remembered that the latter are a year older than the buddings.

Influence of the Direction of the Tapping Cut on the Yield of Budded Trees

A comparison of the yield of buddings of clone B. 95, a clone of moderate yield, tapped on half-circumference with single cuts sloped from left to right and from right to left has been in progress for four years. In the first year the yield from the left-to-right cut exceeded that from the right-to-left cut by 25 per cent, in the second year the difference was 17 per cent, in the third year 8 per cent and in the fourth, 4.5 per cent. Although the left-to-right cut has given the highest yield throughout, the difference has become progressively less.

A similar comparison between half-spiral and 'V'-cuts on buddings has given the following results. In the first year the yield from the spiral cut exceeded that from the 'V'-cut by 9 per cent; in the second year by 3 per cent and in the third year by only 2 per cent.

In both experiments the single left-to-right tapping cut has resulted in the higher yields but the advantage becomes less marked as tapping progresses.

"Double-cut" Tapping on Budded Trees

Tapping on the full circumference of the tree with two cuts at initial levels of 20 inches and 40 inches from the union, with different periods of tapping and rest, has been compared with tapping on half the circumference only at corresponding levels. In a preliminary experiment which has been in progress for four years, alternate-day tapping on two cuts for periods of three months followed by three months rest gave the following results in comparison with single-cut tapping alternate-daily without rest. The trees are now 12 years of age.

	1st year	2nd year	3rd year	4th year
Yield of trees tapped on the 2-cut system as per cent of control* ...	113	120	151	112

**(Control :—mean yield of trees tapped alternate-daily with single cuts on half-circumference at initial heights of 20 inches and 40 inches).*

The drop in the fourth year is in part accounted for by the close approach of the lower tapping cut to the union. The experiment was carried out on a moderate-yielding clone, B. 95; the yield per tree during the 12th year was 8 lb. per annum.

Bark renewal on the double-cut trees is excellent but the critical test of the system will be made when a new cut is opened immediately above a panel on which tapping has just been completed.

The experiment is being repeated on nine high-yielding clones and the results for the first complete year are given.

Clone :—	A.V. 152	A.V. 49	P.B. 23	P.B. 186	B.D 5	Tj. 1	B. 84	A. 44	A.V. 50
Yield on the two-cut system as percentage of yield on single-cut system	109	99	86	82	77	90	81	91	94

The trees were 5½ years of age at the commencement of the experiment. The results of double-cut tapping on the high-yielding clones appear to be less favourable than those obtained in the preliminary experiment on clone B. 95, but the experiment will be continued.

An interesting observation has been made during the course of these experiments; yields of all cuts are recorded separately, and it has been found that on the "two-cut" trees the yield from the high cut is consistently lower than the yield from a cut at the same level

on the "single-cut" trees. Conversely, the yield from the low cut on the "two-cut" trees is generally higher than the yield from "single-cut" trees tapped at about the same level.

Comparison of Yields of Budded Trees tapped on the normal system alternate-daily on half-circumference, on A.B.C. system and on the third-daily system.

In collaboration with estates, experiments have been set up on monoclone plantings of a number of proved clones to compare the above systems of tapping. An area of approximately 60 acres is required for each clone. The oldest experiment, on clone Prang Besar 25, has been in progress for three years. Other similar experiments on Clones A.V.R.O.S. 49, 50 and 152 have been in progress for shorter periods. The principal results are given below. Tapping was commenced at a height of 40 inches from the union with a left-to-right spiral cut on half-circumference.

Clone	Age of Trees at beginning of Experiment	Yield in pounds per acre per annum							
		1st year	2nd year			3rd year			
		Normal a/d	A.D.	A.B.C.	Every Third day	A.D.	A.B.C.	Every Third day
P.B. 25	5 yrs.	578	760	540	545	940	704	728
			100%	*71%*	*72%*	*100%*	*75%*	*77%*
A.V.R.O.S. 49	5½ „	517	555	403	386			
			100%	*73%*	*70%*			
A.V.R.O.S. 50	5½ „	464	522	321	313			
			100%	*61%*	*60%*			
A.V.R.O.S. 152	5½ „	392	441	262	269			
			100%	*59%*	*61%*			

The actual yields for the different clones cannot be compared as the experiments are set up in different localities under different conditions. The chief point of interest in the figures is that the reduction in number of tapping days is reflected in an almost proportional loss in crop. In clones A.V.R.O.S. 50 and 152 the drop in yield on the lighter systems of tapping is even more pronounced. The results indicate that for young buddings of these four clones a normal system of alternate-day tapping on a half-circumference without rest is not too severe a system.

III. Selection and Breeding

Selection of New Parent Trees and the Establishment of New Clones

There have been no additions to the collection of new clones established from high-yielding trees selected on estates. Of those established on the Experiment Station between 1931 and 1933, 139 clones from the total of 290 were prepared for the commencement of tapping in January 1937.

The further selection of promising parent trees is proceeding with the study of seedling families derived from proved clones.

Breeding, Artificial Pollination and Crossing

No new crosses were made during the year, but with the further study of the best proved clones and families of seedlings, now in regular tapping on the Experiment Station, a selection of the most promising parents was made in preparation for a large programme of hand-pollination work in 1937.

Legitimate Seedling Families obtained by Hand-pollination

Tapping of the seedling families of the crosses made between 1928 and 1931 was continued and yields of individual trees were recorded throughout the year. All trees that attained a girth of 20 inches at a height of 20 inches from ground level were tapped. The principal yield records are summarised in Table IV.

The mean yield in pounds per tree for the year for each family is given. In all families in which A. 44 is one of the parents, the yields are very satisfactory. This is particularly evident in the results from the first series of crosses. In the second series, the parent B. 84 was used more extensively and it will be noted that most of the highest-yielding families in the second series have B. 84 as one of the parents.

The secondary characters of A. 44 leave much to be desired. The clone is capable of an exceptionally high yield when young but this appears to be its only virtue. The trunk is irregular in contour and bark renewal is likewise bumpy and corrugated. On the other hand, although the early yield of B. 84 is moderate, the increase with age is very satisfactory and the secondary characters are excellent. In the family of crosses derived from these two parents individuals are found which show all shades of blending of the characters of the parents. The best individuals possess the good secondary characters of B. 84 combined with the high early yield of A. 44. It remains to discover whether the rate of increase in yield will be satisfactory.

TABLE IV. *Summary of Yield Records of Seedling Crosses in 1936*
(Legitimate seedling families obtained by hand-pollination)

Family No.	Cross M F	1928 Series Age on 1.1.36:— 6 years 8 months		1929 Series Age on 1.1.36:— 5 yrs. 9 months to 6 yrs. 3 months		1930 Series Age on 1.1.36 4 yrs. 9 months to 5 yrs. 3 months	
		No. of Trees	Mean Yield in pounds per tree	No. of Trees	Mean Yield in pounds per tree	No. of Trees	Mean Yield in pounds per tree
1	A 8 x A44	7	7.2				
2	A 8 x B58	2	5.6				
3	B58 x A 8	19	7.4				
4	A44 x B58	11	9.3	23	6.3		
5	B58 x A44	2	9.2	35	6.3		
6	A44 x D61	32	9.9	61	6.7		
7	D61 x A44	43	9.6	57	5.7		
8	A44 x B16	27	10.5	74	5.7		
9	B16 x A44	7	9.7	16	7.5		
10	B84 x A44	8	12.6	60	8.0	42	5.1
11	A44 x B84			10	5.8	40	5.5
12	B58 x D61	8	5.7				
13	B58 x B16	10	8.9	5	8.7		
14	B16 x B58	2	6.9				
15	D61 x B16	4	7.7	3	4.6		
16	B16 x D61			4	1.9		
17	A44 x B50			17	5.7		
18	D65 x A44			3	2.9		
19	A44 x D65					8	2.4
20	B50 x B58			13	4.6		
21	B58 x B50			10	5.5		
22	B58 x B84			11	7.0	14	3.6
23	B84 x D61			12	6.5		
24	D61 x B84			32	6.9		
25	B84 x B16			29	6.0		
26	B16 x B84			5	8.7		
27	D65 x B16			5	4.4		
28	A44 x B65					4	3.6
29	B65 x A44					5	2.4
30	D65 x B84					13	2.5
31	B84 x D65					20	3.1
32	B50 x B84					13	3.8
33	B58 x D65					3	2.3
34	B58 x B65					1	4.3
35	C72 x B84			5	8.2		
36	B58 x C72			3	9.0		
37	B90 x B16					4	1.4
38	B50 x E95			3	5.6		
39	B95 x A44	9	8.3				
40	A44 x Lun N			18	6.4		
41	B84 x Lun B					2	3.0
42	Lun K x Lun N			2	4.4		
	MEAN YIELD OF ALL FAMILIES		8.6		6.1		3.3

The seedling families of the second series of crosses were planted at the same time as the buddings of the clones in Block 5. Although a close comparison cannot be made, the buddings and seedlings have been grown under very similar conditions and a fair indication of the relative merits of the trees can be obtained by comparing the yields given in Table I with those for the 1929 series of crosses in Table IV. The average yield of all families is greater than that of the clones but less than that of the highest-yielding clones Tjirandji 1 and A. 44. The best seedling families have given higher yields than the best clones.

The variation in yield within a family, although considerably less than in seedlings of mixed parentage, is greater than the variation in yield of buddings of a clone. The coefficients of variability are, for mixed seedlings 60 to 70; for legitimate seedlings of single families 25 to 40; and for buddings of single clones 20 to 30.

Within each seedling family certain individual trees have given exceptionally high yields. The following are selected examples.

Family No.	Cross M.	Cross F.	Yield in pounds per tree of highest-yielder in each series		
			1928 series Age 6½-7½ yrs.	1929 series Age 6-7 yrs.	1930 series Age 5-6 yrs.
6	A 44	D 61	18.1	17.6	—
10	B 84	A 44	25.9	21.9	13.3
13	B 58	B 16	20.0	18.0	—
22	B 58	B 84	—	16.8	—
23	B 84	D 61	—	18.3	—

Each record in the above table represents the actual yield of dry rubber harvested from a single tree during 1936.

The seedling cross of B. 84 × A. 44 from the 1928 series (Family No. 10) was tapped for seven months only and during this period yielded nearly 26 pounds dry rubber. The tree then went "dry" repeating the behaviour of the previous year. There are none of the symptoms of severe brown bast and it is proposed to tap this tree every fourth day in future. Buddings from this parent tree gave 13.2 lb. per tree during the first tapping year at the age of five to six years.

New Clones derived from Legitimate Seedling Crosses

From the majority of the crosses included in the 42 legitimate families, clones were made when the seedlings were from one to two years of age. A large number of these new clones were tapped dur-

ing the year. The principal results from the first series, consisting of 129 clones derived from the 1928 crosses, are briefly described.

The yield records from the new clones show that on the whole the highest-yielding individuals from the best families have given the highest-yielding clones. For example, the average yield of six clones derived from the family B. 84 × A. 44 was 6.3 pounds per tree; the yield of the best clone from this family reached the high level of 13.2 pounds per tree in the first tapping year. The buddings were five years old on 1st January, 1936.

Results of the same order have been obtained from the early tapping tests on the new clones derived from the younger seedling families and a selection of the most promising clones was made towards the end of the year. The first selection was based on the yield records and this was followed by careful examination of secondary characters, growth, branching habit, quality of the bark, bark renewal and incidence of disease. In this study the importance of the secondary characters of the parents is strikingly revealed; in the majority of the clones derived from crosses which have A. 44 as a parent the unfavourable characters of this parent appear in the buddings. The most promising new clones are for the most part descended from B. 84 and A. 44 and these clones are being planted on a large scale for further test on the Experiment Station (Block 30) and on experimental areas on a wide range of soils on estates.

Illegitimate Seedlings derived from High-yielding Clones

From the buddings of parent clones used in the hand-pollination work from which the families of seedlings described above were obtained, seeds were also collected which had developed normally without artificial control. Only the mother parent of these seeds was therefore known with certainty and the families of seedlings grown from them are described as illegitimate families of the clone of origin. These illegitimate seedlings were inter-planted with the crosses in each series and have received the same treatment throughout.

The yield records of the principal families during 1936 are summarised in Table V.

Although the yields of the illegitimate seedling families are lower than those of the legitimate families of crosses, they are nevertheless very satisfactory. The high yields of the seedlings from clones A. 44 and B. 84 are noteworthy. The very high average yield of the seedlings from B. 84 in the 1929 series strengthens the evidence of the value of this clone for further use in breeding and selection work.

TABLE V. *Summary of Yield Records of Illegitimate Seedling Families derived from the principal Parent Clones (cf. Table IV)*

Family	1928 Series Age on 1.1.36:—6 yrs. 8 mons.		1929 Series Age on 1.1.36:—6 yrs. 5 mons.	
	No. of trees	Mean Yield in pounds per tree	No. of trees	Mean Yield in pounds per tree
A. 44	149	7.9	58	5.7
B. 58	73	6.5	62	5.0
B. 84	20	8.2	135	6.9
D. 61	28	6.3	46	5.3
B. 16	6	5.2	23	4.9
D. 65			28	3.4
B. 50			26	4.6

The degree of variation in yield in the illegitimate families is greater than in the families of crosses, as would be expected from their more diverse origin. From the best families a number of very high-yielding individuals have been selected which will be used as mother-trees of new clones. The results from the early tests on clones derived from the best legitimate seedlings indicates that valuable new clones may be obtained from the new selections. As an indication of the value of the new clone parents the records of four illegitimate seedlings derived from B. 84 are given. These four trees yielded respectively 31.5 lb., 23.5 lb., 20 lb. and 17 lb. dry rubber between the ages of 6½ and 7½ years under a normal system of alternate-day tapping on half-circumference.

Seedlings from Isolated Seed Gardens

In 1928 small families of seedlings derived from each of 25 parent clones established in the Tjikadoe isolated seed garden of the Anglo-Dutch Estates in Java were planted on the Experiment Station (Block 2). These seedlings were regularly tapped throughout the year, the second year of normal tapping, and the principal records are presented in Table VI.

The high average yield of 9 pounds dry rubber per tree is very good and represents an increase of 4.5 pounds per tree on the yield in 1935. At the same time, the mean yield is considerably lower than that obtained from buddings of the best clones at comparable age, from legitimate seedling crosses or from illegitimate seedling families from the best parents.

TABLE VI. *Summary of Yield Records of Families of Seedlings from an Isolated Seed Garden*

(*Age of Trees*:—7¼ *to* 8¼ *years*)

FAMILY	No of Trees	Yield in pounds per tree	FAMILY	No of Trees	Yield in pounds per tree
1	9	10.5	14	6	9.4
2	12	11.6	15	13	11.1
3	10	7.2	16	7	4.7
4	10	5.2	17	10	12.2
5	13	5.1	18	10	7.2
6	11	9.1	19	13	7.1
7	12	12.2	20	15	**16.8**
8	11	6.2	21	8	9.6
9	5	9.6	22	9	10.8
10	9	**17.4**	23	9	7.7
11	9	6.6	24	10	8.7
12	7	9.0	25	7	3.7
13	9	5.8			
			All trees	244	9.0

The chief feature of interest in these records is the wide range of the yields of the different families. It will be evident that the value of the seed from a mixed seed garden of this type will depend on the proportion of the seeds present which are derived from the best parents. If it should happen that the lowest-yielding parents *e.g.*, 4, 5, 13 and 25 are the most prolific seed-bearers then the average yield of the offspring is likely to be well below the satisfactory level obtained in this test; on the other hand, should the parents 7, 10, 17 and 20 prove the best seed-producers the value of the seed crop will be much increased.

In this collection of seedlings there is also a considerable number of very high-yielding individuals. The two trees that gave the highest yields during this year were one of family 10 with a yield of 33.7 lb. and one of family 20 with a yield of 35.0 lb.

The Early Determination of Yielding Qualities of Seedlings

In view of the excellent results obtained in the study of families of seedlings obtained from good parent clones it has become increas-

ingly desirable to develop methods of ascertaining the potential value of a seedling at the earliest possible age.

(i) A method of selection at the age of one year based on a pricking test and grading the seedlings according to the amount of flow of latex has been tested. No great degree of accuracy is claimed for the method, but from the results obtained so far we have not been able to discover any close relationship between the records of latex flow in the nursery and the records of yield at test-tapping three years later in the field. The method does, however, enable us to eliminate the majority of the lowest-yielding class of seedlings.

(ii) The records from short periods of test-tapping of seedling trees at an early age have been correlated with the records of yield obtained during the first two years of normal commercial tapping. Test-tapping was commenced when the trees were 3¼ years of age and was repeated at intervals of six months until regular tapping commenced when the trees were 6¼ years old. At each test the total weight of rubber obtained from five consecutive tappings, after a preliminary period of five days tapping, was recorded for each tree. The correlation between the yields obtained from successive tests and those during two complete years of normal tapping are given below.

No. of Test	Age of Trees	Coefficient of correlation between yield of test and total yield at	
		6¼ to 7¼ years	7¼ to 8¼ years
1	3¼	+ 0.77	+ 0.68
2	3¾	+ 0.75	+ 0.76
3	4¼	+ 0.85	+ 0.77
4	4¾	+ 0.83	+ 0.86
5	5¼	+ 0.80	+ 0.80
6	5¾	+ 0.85	+ 0.83

The high value of the coefficients of correlation indicate that even the earliest tests at 3¼ years have given a very good indication of the future yield value of the trees.

IV. Ecological Studies

Cultivation of Rubber Trees in Association with Indigenous Plants and Leguminous Covers

Experiments on the use of so-called "natural" covers in association with rubber trees have been described in previous reports. An area of 50 acres (Block 27) on hilly land on the Experiment Station has been developed to compare different methods of cultivation with cover plants. Five methods of treatment are compared; three with

indigenous plants controlled in different ways, one with leguminous shrub species and one with leguminous creeping species.

In the first system indigenous plants were allowed to develop between the cleared and cultivated terraces occupied by the rubber trees. Control of growth of the plants between the rubber tree rows is limited as far as possible to occasional lopping of the most vigorous species which threaten to over-shade the rubber. The dominant species at the end of the first year (1935) were the three common species of *Trema* (locally known as "Wild Cherry"). At the end of 1936 these had been suppressed by a number of small tree species. The chief species in order of dominance were *Endospermum malaccens,* several species of *Macaranga, Sapium* and *Ficus, Anthocephalus candaba* and *Evodia glabeata.* Beneath these tall species in the undergrowth of shrubs and seedlings *Psychotria viridiflora, Timonius* spp., *Solanum torvum* and, in the more open situations, seedlings of *Trema* were most abundant. The lowest stratum was dominated by the fern *Nephrolepis biserrata* and small colonies of *Hornstedtia* spp. ("Wild ginger"). With the development of shade the ephemeral weeds and soft grasses have largely disappeared except on the edges of the cleared terraces.

In the second system the growth of indigenous plants is controlled by lopping to a height of about three feet at regular intervals. All the small tree species recorded above are present with the addition of other species, in particular *Ficus alba,* which appears to survive frequent lopping and to thrive well in an open situation. The dominant species, however, is *Nephrolepis biserrata* and this fern with species of wild ginger frequently forms a complete cover between the cultivated terraces.

In the third treatment a similar method of control by frequent slashing is practised and in addition all ferns are removed. The species found in the previous treatments all occur here, *Hornstedtia* has replaced *Nephrolepis* as the dominant ground cover and ephemeral weeds are more abundant.

The plots planted with shrub legumes *Crotalaria anagyroides, Tephrosia candida* and *Leucaena glauca* (Lamtoro) are lopped periodically at a height of three feet. After the second lopping Crotalaria made a poor recovery and by the end of 1936 very few plants remained. *Tephrosia candida* on the other hand appears to improve with lopping and is now the dominant species. Lamtoro made very slow growth at first but by the end of 1936 it had developed well, taking the place of *Crotalaria* which had been much more abundant previously. It was evident at an early stage that on the light sandy soil on the Experiment Station these shrub covers alone were unable to check soil erosion adequately. Early in 1936 *Desmodium ovalifolium* was planted on the lower edges of the terraces and *Clitoria laurifolia* on the upper edges. Desmodium has developed

well to form an excellent protective cover on the edge of the terrace and is spreading vigorously under the shade of Tephrosia and Lamtoro.

In the plots planted with the three creeping legumes, *Calapogonium mucunoides, Centrosema pubescens* and *Pueraria phaseoloides*, the latter has become dominant over the whole area. Centrosema survives in small isolated patches but is rapidly being smothered by the more vigorous Pueraria.

Measurements of the growth of the rubber trees made at 1½ years from the date of planting failed to show any significant differences in the growth under different methods of cultivation. It is not intended to take further measurements until the trees are 3 years old.

V. Field Experiments on the R.R.I. Experiment Station

The undermentioned additions are made to the Schedule of field experiments published in previous Annual Reports.

Block	Acreage	Description of Experiment	Date of Commencement
15 A	8.25	Portion of old elephant belt. Cleared in strips without burning. Planted with clonal seedling families derived from clones, P.B. 31, Rubana 393, A.V.R.O.S. 183, Pilmoor B. 84 and B. 16, B.R. 1 and 2, B.D. 7, S.R. 1. TK 12, 14 and 26, R.A. 20, Lam. 2 and Waringiana 4	November 1936
23 A	6.75	As 15A. Western section, Planted with clonal seedlings from Clones P.B. 186, 123, 86 and 49; A.V.R.O.S. 33, 52 and 185; B.D. 5 and 10; Tjir. 16, Glenshiel 1 and Ct. 88. Southern section, Mixed seed of A. 44 and B. 84 from Pilmoor Estate (Duoclone planting)	December 1936
6 A	5	Nursery for collection and study of root development of clonal seedlings	July 1936
12	7	Replanted from old nursery site to test families of seedlings derived from the highest-yielding crosses and illegitimate clonal seedlings	October 1936

VI. Field Experiments on Estates

Under the International Agreement for the regulation of rubber production the limited planting of reserve jungle land for experimental purposes is permitted.

The total area available for Malaya is approximately 8,000 acres. Of this total an area of about 1,400 acres had been allocated for development at the end of 1935. During 1936 a large number of further applications to develop reserve land for experimental purposes were received and further selection of areas suitable for experimental work was made by Officers of the Soils Division and the Botanical Division. By the end of 1936 a further area of about 2,000 acres had been allocated for botanical experiments. The experiments cover a wide field and include the testing of new planting material, new clones and families of clonal seedlings, the study of environmental conditions on different clones, influence of methods of cultivation on growth of rubber, study of development of indigenous covers after different methods of treatment of the original jungle. Other experiments have been planned and will be conducted jointly with the Soils Division. A summary showing the present position in regard to the development of experimental areas is given in an Appendix to the Director's report.

VII. Advisory Work

Correspondence

The total volume of correspondence during the year 1936 was more than double that of the year 1935. Details are given in an Appendix to the report of the Director.

The increase in the volume of work involved has been due to the widespread interest in replanting and the consequent interest in the choice of planting material, cover plants and related subjects. Enquiries on the choice of planting material increased from 232 in 1935 to 418 in 1936, general planting enquiries, *e.g.* methods of planting, budding, choice of cover plants etc., increased from 186 to 389. The greatest increase was in the work involved in connection with the scheme for experimental planting on reserve land. Enquiries dealt with under this head rose from 74 in 1935 to 578 in 1936.

Estate Visits

The visits paid to estates by members of the staff of the Division in connection with advisory and experimental work are shown below.

Member of Staff		*Advisory Visits*	*Research Visits*
C. E. T. Mann	...	87	38
C. C. T. Sharp	...	31	52
E. D. C. Baptist	...	7	65
K. N. Kaimal	...	—	81
T. V. Vaidyanathan	...	—	39
		125	275

The increase in requests for visits to estates to advise on problems relating to replanting was greater than could be met with the existing staff. Visits paid in connection with experimental planting of reserve areas are included under research visits.

Interviews and Visitors

The number of visitors increased from 85 in 1935 to 164 in 1936. As in previous years, most of the visitors were estate Managers or Agents who were chiefly concerned with such problems as choice of planting material, buddings and families of clonal seedlings, cultivation methods and treatment of cover plants and details regarding the development of experimental areas. The number of visitors from other rubber-growing countries, particularly from the Netherlands East Indies and Ceylon, showed a marked increase on previous years.

Lectures

Lectures were given by the Senior Botanist at meetings of the Incorporated Society of Planters :—

(a) Tanjong Malim Branch on 18th June 1936
A lecture on the progress of work on selection of planting material.

(b) At The Annual Conference of the Society on 2nd October 1936
A lecture on tapping of budded trees.

VIII. Publications

(1) "Tapping of Budded Trees" by C. E. T. Mann
The Planter—October 1936, page 430.

(2) "Progress of the Study of Buddings and Seedlings on the R. R. I. Experiment Station" by C. E. T. Mann
The Planter—October 1936, page 477

(3) "Note on Preliminary Results from the Study of Seedling Trees derived from Proved Clones" by C. E. T. Mann
R.R.I. Journal Vol. 7, No. 1

C. E. T. Mann
Senior Botanist.

ANNUAL REPORT

PATHOLOGICAL DIVISION

Staff

Mr. R. P. N. Napper returned from leave at the beginning of January, and for a short period the Division was again at normal strength. Early in May, however, Mr. F. Beeley proceeded to England on eight months' furlough, and for the remainder of the year the European staff was once more reduced to a single officer.

In November the vacant post of Assistant Pathologist was filled by the appointment of Mr. K. P. John, B.A., (Madras).

Mr. H. C. Chuan, the Institute's artist and photographer, continued under the charge of the Division. As in previous years his work maintained a high standard of excellence.

The remainder of the staff gave valuable service, particularly during the difficult period following the fire.

Progress of Research

As in the previous year research was seriously handicapped by shortage of staff, and little progress was possible except in connection with problems of immediate practical interest.

The difficulties of research were further enhanced by a heavy increase in advisory work, details of which are given at the end of this report.

Owing to the late arrival, in a damaged condition, of the Elconap cold incubator no laboratory research was carried out on the life history and environmental relationships of the leaf mildew fungus *Oidium Heveae*. The usual seasonal work in the field gave further support to the conclusion that weather and environment are of paramount importance when considering the occurrence and virulence of this fungus.

The occurrence of Leaf and Stem diseases of budded clones continues to receive attention, as a result of which the importance of water relationships and various nutritional factors is more generally realised as a cause of certain pathological conditions in young rubber arising from what are now regarded as bad agricultural practices.

The wet weather experienced in January enabled further tests of various proprietory fungicides to be carried out, and towards the end of the year the testing of a further four tar-distillate fungicides in control of Mouldy Rot was commenced.

Bacteriological work during the year consisted chiefly of the continuation of the investigation into the effect of manuring on soil bacterial numbers and the effect of various seasons of the year. The bacteriology of latex received very little attention during the year owing to the unsatisfactory condition (for our purpose) of latex harvested during the wintering and refoliation period and to the absence of Mr. Beeley for the remainder of the year.

Root Disease Investigations

The main problems studied in this connection were:—

(1) the control of root disease in mature rubber areas

(2) the eradication of root disease in areas about to be replanted.

These problems aroused little public interest prior to the introduction of rubber restriction. Lack of interest was due partly to scepticism regarding the seriousness of the root disease menace, and partly to lack of confidence in the recommended methods of control. Two factors, however, have recently combined to bring these problems into special prominence, viz:—

(a) the ban on new planting, which has created a much more pressing need for the protection of existing trees, and for the rehabilitation of vacant and unprofitable areas;

(b) a general increase in the rate of mortality from root disease in mature areas, of a magnitude sufficient to convince the industry of the gravity of the root disease situation, and of the need for immediate and drastic action in relation to control. This increase has been due in part to the temporary cessation of control measures during the recent economic depression, but is mainly a natural consequence of the increasing age of rubber plantations in this country, the rate of mortality rising rapidly with increase in the size of the infected areas.

Revival of interest in the above problems was noticeable at the end of 1934, though at that time only a few of the more progressive or more prosperous estates were able to give expression to the change in policy. During 1935, however, economic recovery proceeded at a rapid rate, and by the beginning of the year under review, most properties were in a position to undertake the necessary work. The result was a wide-spread demand for information and advice on these subjects, in response to which it was necessary to devise simple practical methods of procedure which could be safely recommended as a general basis for dealing with these problems in the field.

Control of Root Disease in Mature Areas

An improved method of control for use in mature areas had been under investigation since 1933, and sufficient data had accumulated to show that the method was technically sound, and quite suitable for use on plantations. During the earlier part of the year this method was therefore adopted for general recommendation.

The method embodies the classical principle of isolation by means of trenches, but modifications have been introduced to remove the numerous causes of failure which made the method so unreliable in the past.

The more important of these causes were:—

(i) the indiscriminate use of the method in stands of all ages,

(ii) incorrect placing of the trenches,

(iii) faulty methods of maintenance.

With regard to (i) it is now realized that the method is only applicable in mature areas. It is useless in young plantations before the root systems of the rubber trees have come into contact with one another, and does not attain its full value until the position and extent of the groups of infected jungle stumps are known with some degree of accuracy. This condition is not fulfilled until the stand is about 15 years of age. In stands above this age, however, the method is quite satisfactory. In such areas spread of infection takes place solely by radial expansion around the sites of the original groups of infected jungle stumps, the parasites passing from rubber tree to rubber tree by root contact. Complete control can therefore be obtained by encircling each root-diseased area with a properly dug isolation trench. These trenches sever all root contact between the infected areas and the surrounding healthy stand, and if properly maintained render further spread of infection impossible.

With regard to (ii) the correct placing of an isolation trench is no longer a difficult matter now that the habits of the root parasites are more intimately known. In order to determine whether a trench is passing inside or outside the boundary of a root-disease patch, it is merely necessary to examine the root sections removed as the trench progresses. If all sections are healthy the trench is known to be correctly placed; if some are infected, the trench is known to lie within the boundary of the infected area, an outward deviation being necessary to bring it into its correct position in relation to the patch. It is a very simple matter to determine whether or not a root is infected. The root parasites (*viz. Fomes lignosus, Ganoderma pseudoferreum* and *Fomes noxius*)

are propagated by means of conspicuous external growths of mycelium called rhizomorphs which contrast sharply with the clean surface of healthy bark, and are particularly easy to recognise near the limit of spread of infection, i.e. *in the region where root inspection is necessary.*

The correct maintenance of isolation trenches (item iii) is a much more difficult problem. The classical recommendation was to keep the trenches permanently "open" by cleaning out all silt and vegetable debris at regular intervals. This method, however, can only succeed where the soil is shallow and overlies a substratum impervious to roots. In soils of normal depth open trenches are incapable of acting as permanent barriers to the spread of root disease. New rootlets produced from the ends of the severed laterals find their way down the sides and under the floors of the trenches, and within a year or two after the original digging root contact is again established between the diseased and healthy areas. These new contacts may of course be severed by deepening the trenches, but this is not a practical solution of the problem, for the process would have to be repeated at regular intervals, and the work would become more difficult and more expensive at each operation. The only simple and satisfactory method is *to refill the trenches as soon as they have been dug.* All new contacts are then established *above* the floors of the trenches, and efficiency can be restored wherever necessary by redigging the trenches *to their original depth.* The trenches become full of small roots within six months after cutting and refilling, but the spread of disease through this maze of rootlets is slow, and it is unnecessary to repeat the process oftener than once every 1½ to 2 years. At each redigging the root sections are examined in the usual way, and if any infected roots are found passing beyond the outer walls of the trenches they are followed up individually and removed.

There is no necessity to refill the trenches level with the surface of the ground. There should, however, be at least 18 inches of soil in each trench above the original floor level. For refilling the trenches there is no advantage to be gained in importing fresh soil. Unless the trench is badly placed, and cuts into the edge of the diseased area, the original soil will be free from infected roots and quite suitable for use. Even if the soil does contain infected roots no damage will be done by putting it back into the trench, for in such a case infection must already exist on the far side of the trench, and the return of infected material cannot make the situation any worse than it is already.

Root Disease Eradication in Mature Areas

Control by isolation, though technically sound, suffers from two serious economic disadvantages, the importance of which was

not fully recognised until the method began to be used freely on estates. They are (a) that it entails continuously recurrent expenditure on the upkeep of the trenches, and (b) that it does nothing towards preparing the infected areas for supplying or replanting.

Later in the year attention was therefore turned to the alternative method of control, *viz.* control by eradication, which has neither of the disadvantages mentioned above, but has never attained any measure of popularity on account of its high initial cost.

Preliminary observations showed that the method is by no means as expensive as was formerly supposed. It entails digging over the whole area of each individual root disease patch, but deep expensive work is unnecessary except at the heavily-infected margins. The centres of the patches are fairly free from infection (most of the original infected roots having rotted away) and for the most part require only a shallow exploratory digging, 9 to 10 inches deep, to reveal areas where infected roots still remain unrotted in the soil and where deeper digging is therefore necessary.

The moderate nature of the cost can be illustrated by considering average figures for eradication in stands 25—35 years of age. In such stands disease patches usually occupy about 25 per cent. of the planted area, but of this infected ground not more than 30 per cent. requires expensive digging. Taking the cost of deep (marginal) and shallow (central) digging at $80 and $30 per acre respectively (both fair average figures) the cost of the work becomes $45 per acre treated, which reduces to the modest sum of $11 per acre when the cost is spread over the whole planted area.

This figure compares very favourably with the cost of digging isolation trenches, which in an area such as described above may be taken as $3 to $5 per acre in the first place, plus $1 to $2 per acre for upkeep every second year. It should be remembered, however, that in addition to this expenditure the full cost of digging has still to be incurred when the isolated areas are replanted or supplied. In the long run therefore immediate eradication is unquestionably the cheaper method of control.

Based on the above considerations immediate eradication has now been adopted as the standard method of control in mature areas. Isolation trenches however can often be used very profitably in conjunction with eradication, *e.g.*, when the area to be dealt with is large, and digging operations have to be spread over a considerable number of years.

Eradication of Root Disease in Areas about to be Replanted

In the few areas which were replanted prior to the recent economic depression the general method of preparation was to dig

the whole area over to a depth of at least 18 inches, and to remove all roots from the soil whether healthy or diseased.

Judged by present standards this method appears unnecessarily expensive, and in recent years it has been the custom to advise digging over the disease patches only, leaving the lateral roots of the trees in the healthy areas to rot away naturally in the soil.

This method is sound in theory, but it was not until the year under review that replanting became general enough to enable a detailed practical study of the method to be commenced.

As a result of preliminary observations the following conclusions were reached :—

(1) that in order to attain maximum efficiency the digging of the disease patches should be completed *before* general felling is commenced;

(2) that whatever method of clearing is employed, a number of root-disease losses must be expected to occur in the young stand during the first four or five years after replanting;

(3) that provided all known disease patches are properly dug over at the time of felling:—

(a) the subsequent root-disease losses are few in number, and can be dealt with cheaply and easily by means of the standard treatment for young areas;

(b) complete and permanent eradication may confidently be expected by the time the replanted stand is mature.

With regard to (1) this method of procedure has many advantages over the more usual method of digging over the disease patches *after* felling. Before felling, the patches are clearly marked by gaps in the original stand, while their outer limits can be determined precisely in the course of digging because the root systems of the surrounding healthy trees are still green and full of latex. After felling, however, the work becomes more difficult and less reliable. The ground is then littered with fallen timber, which hampers digging operations and obscures the outlines of the patches, while the roots of the healthy trees soon begin to decay, and it soon becomes difficult for coolies to distinguish between roots killed by root parasites, and those which have died merely as a result of mechanical severance from the bole. A further advantage of the method is that it allows eradication to be carried out by the normal estate pest gang, and to be spread over any convenient period of time, thus greatly facilitating supervision. If eradication has to be rushed through between felling and planting, probably with the help of a large temporary labour force, efficient work is very difficult to ensure.

With regard to (2) many of these losses occur in treated soil, being caused by small pieces of infected root accidentally overlooked in the course of digging. Such losses are familiar in all replanted areas, and are only to be expected considering the quality of the labour available. Of greater interest are the losses which occur in *untreated* soil, *i.e.* in areas of the clearing which were apparently healthy at the time of felling. These losses are invariably caused by contact with infected roots belonging to the original stand, but the existence of such roots in "healthy" areas is sometimes rather difficult to explain. In general, however, they may be regarded as old infections in which the disease has lain dormant for very many years until brought into activity again by the process of felling.

The causes of dormancy are still somewhat obscure. The most common cause in the field appears to be continuous saturation with water. This is shown by the fact that losses of the type under consideration are most abundant in low-lying coastal areas where the water-table was originally high, but has been extensively lowered in the process of replanting. The causes of dormancy on inland soils are less important and not so clearly understood. They will be studied more closely, however, when occasion permits.

With regard to (3) an exception must be made in respect of coastal soils, especially peats, where heavy losses are sometimes experienced in undug areas, even if these areas showed no signs of root disease at the time of felling. As explained above these losses are caused by dormant sources of infection brought into activity by the lowering of the water-table. These sources are probably small in the first place, but quickly expand by radial spread in the severed, but still living, laterals of the original trees. The spread of infection in such moribund roots is exceedingly rapid, and continues until they begin to be colonized by saprophytic organisms. By this time (6-12 months after felling) anything up to 20 per cent. of the area of the clearing may have become infected with root disease.

Experience has shown that the attack can be dealt with successfully by standard treatment, but the cost is sometimes high, and it may prove more economical in the long run to dig over the "healthy" as well as the infected areas when clearing the original stand. There is no necessity to dig very deeply in the "healthy" areas. The main object is to break up the continuity of the surface laterals, and hasten their decay. A similar shallow cultivation of healthy areas may also prove to be of economic value on inland soils. This, however, is at present problematical, though the removal of tap roots in such areas is strongly recommended.

Diseases of the Tapping Panel

Mouldy Rot *(Ceratostomella fimbriata)*

This serious disease was much less troublesome than usual, being kept in check over the greater part of the country by unfavourable weather conditions. A six weeks' drought during the wintering period was followed in many districts by an exceptionally long spell of hot and dry weather during the months of June, July and August. These successive periods of drought so reduced the vitality of the causal organism that normal development was delayed until the beginning of the month of December.

Additional factors tending to reduce the incidence of infection were the selling of export rights by small-holders, and the growing popularity of lighter tapping systems on estates.

Several new fungicides were due to be tested but for reasons indicated above the field trials could not be commenced until late in the year, and the results are not available for comment in this report.

The comparatively rare perithecial (*Ceratostomella*) form of the parasite was seen on several occasions during the dry period of June to August.

Black Stripe and Patch Canker (*Phytophthora* spp)

As in the case of Mouldy Rot, these diseases were influenced by the prevailing dry weather conditions, the incidence being well below the average for a normal year. Distribution, however, was normal. Both diseases were prevalent in South Kedah, Black Stripe occurring also in the various coastal districts, notably in Lower Perak.

While investigating an outbreak of Black Stripe in the latter district an interesting demonstration was observed of the effect of humidity on the incidence of the disease. An outbreak of Black Stripe during the rainy season is an annual event on the estate concerned but bark damage has been noticeably more severe since the weeding policy was changed some six or seven years ago. The area had previously been clean-weeded, but now carries a heavy cover of *Centrosema pubescens*. By reducing the rate of run-off of surface water, and impeding the movement of air round the bases of the trees, this cover has increased the humidity of the air about the tapping panels, and has made conditions much more suitable for the development of the disease.

Another point of interest observed on the same estate was the successful healing of large wounds caused by the excision of infected bark during a round of drastic Black Stripe treatment

carried out in 1934. Some of the wounds were then more than a square foot in area, but in two years have been reduced to less than half this size by the in-growth of callus from the edges. The callus is smooth and regular in thickness, and should provide an excellent surface by the time the treated panels are opened again for tapping.

An interesting bark canker, showing characters typical of both Patch Canker and Black Stripe, was reported from an estate in Kedah. As in Patch Canker, the lesions developed on untapped as well as on tapped bark, but the disease resembled Black Stripe in producing fine black lines in the underlying wood. These lines followed the grain of the wood, and passed downwards beyond the lower edges of the bark lesions. The manager was of the opinion that these lines were instrumental in spreading the disease through the bark, since excision of the *diseased* bark plus treatment with a fungicide was not sufficient to prevent further extension of the lesions. He reported, however, that control could readily be obtained by cutting away the surrounding healthy bark down to the limit of spread of the black lines.

It is hoped that a more favourable opportunity for investigating this interesting disease will occur in 1937.

Stem and Branch Diseases

Pink Disease (*Corticium salmonicolor*)

Pink Disease, which is less sensitive to desiccation than the foregoing bark diseases, was markedly less influenced by weather conditions, and in fact attained an added importance as a result of the rapid extension of the policy of replanting. Small blocks of immature rubber surrounded closely on all sides by mature trees are particularly liable to Pink Disease infection especially in the wetter districts.

Control in these young areas presents considerable difficulty. The standard asphalt-kerosene—disinfectant mixture, which is highly satisfactory on older trees, is liable to cause serious bark burning on young stems fully exposed to the sun, while water-miscible fungicides are easily washed off by the rain, and sometimes tend to give disappointing results in the field.

To prevent overheating of the treated surfaces, and to obtain improved adhesion, a mixture of a water-miscible fungicide with lime-wash is sometimes employed. If this method is adopted care should be taken to ensure that the mixture is made up freshly every day, and that the lime-wash is allowed to stand for at least 24 hours before mixing with the disinfectant.

Die-back in Budgrafted Areas

Two interesting cases of die-back in budgrafted areas were investigated during the year. In each case the clone affected was one of a pair in a "duo-clone" block, the clones being planted in alternate rows. One of these cases will be briefly described, the affected and unaffected clones being referred to as A and B respectively.

The area in question was a 20-acres replanted block on a well-drained coastal soil. The stand was six to seven years of age, and until the previous year had grown quite satisfactorily. Following the wintering period of 1935, however, a few trees of clone A developed die-back in the crown, some trees being so severely damaged that they had to be pollarded. The affected trees occurred in groups, and the damage at the time was attributed to lightning.

No further cases were recorded in 1935, but during the year under review the trouble recurred with greatly increased severity, again appearing just after the wintering period. During this second attack nearly every tree of clone A developed die-back to a greater or less degree. Clone B, however, remained entirely unaffected.

In view of the wide distribution of the die-back, and its strongly selective action, the lightning hypothesis had to be discarded. It was more reasonable to assume that the die-back was due to a struggle between the two clones for some temporarily deficient nutrient in the soil, to the lack of which clone A is very sensitive, or for the absorption of which its root system is comparatively poorly equipped.

This explanation was in good agreement with the available evidence. The wintering periods of 1935 and 1936 were both very dry, and temporary drought as the primary cause of injury was highly probable; while with regard to the possibilities of root competition the methods of branching of the clones suggest that A encourages a shallow, and B a deep-rooting habit, which would readily explain the strongly selective action of the "disease". No direct evidence of such a difference in structure is at present available, but it is understood that the suggestion is a very reasonable one, and is likely to be confirmed when root studies on these clones are undertaken.

The suggestion that the die-back was primarily due to drought was supported by examination of the affected tissues. No likely parasites were found, but in every case the injury commenced in the topmost branches and travelled systematically down the main stem, thus suggesting inability of the translocation stream to supply the remoter parts of the crown. It is possible, of course, that the effect of drought was accentuated by a deficiency of

available potash in the soil, this nutrient playing an important role in the formation and function of the conducting tissues.

That the phenomenon was due to a weakness on the part of clone A, rather than to any unusual vigour on the part of clone B. was shown by the fact that two other duo-clone combinations in the same replanted area, both including clone B, showed no symptoms of injury. A duplicate block of A and B, however, developed an exactly similar type of die-back, though in milder form.

Duo-clone plantings of A and B on two neighbouring estates were not affected. It would appear that in these areas the water supply remained continuously above the critical level.

No further cases of die-back occurred during the local severe drought of June to August 1936. This may appear surprising at first sight, but is probably due to the fact that the water requirements of clone A had been considerably lowered by the heavy loss of crown which occurred earlier in the year.

The above arguments infer that clone A is abnormally susceptible to drought. No such weakness was observed, however, in any other plantings of the clone. The total area under this clone, however, is very small, and data on this subject is necessarily limited.

It is unlikely that above-ground competition played any significant part in producing the die-back, for the clones were equally well grown at the time when the trouble commenced.

A second case of die-back in a duo-clone block was reported from another coastal estate during the dry period of June to August. Two different clones were involved, but the features of the case were essentially similar to those discussed above. Again there was little doubt that competition for a scanty supply of soil moisture was the principal cause of trouble.

In this second case the affected clone is widely planted and is known to be susceptible to drought.

Leaf Diseases

Leaf Mildew (*Oidium Heveae*)

The weather experienced in Malaya during the early part of 1936 was unusual, in that the month of January, which is usually a dry month, showed heavy falls of rain at most meteorological stations throughout the country. The effect of the wet weather in January was to delay wintering by at least four weeks, particularly in the central and northern parts of Malaya. The dry easterly winds following the north-east monsoon rains did not

materialise until the second week of February when the hot dry weather began. This dry weather continued for several weeks, thus inducing a good, severe wintering of rubber trees in most parts of the country, while in the later period of drought much new foliage in excellent condition, entirely free of mildew, was produced. On 10th March a distinct break occurred in the weather and dull days with local showers or drizzle became more or less general throughout the country. It is interesting to compare the dates of the above weather changes with those of 1935, which were as follows (a) fine weather commenced first week in January, (b) dull showery weather commenced February 14th, after which dates *Oidium Heveae* became noticeable.

By March 10th over 50 per cent. of the trees, and in some districts 70 per cent. or more, had obtained their new foliage to a degree which would ensure freedom from attack by the mildew fungus. However, from this date onwards, as a result of the dull, showery weather, the disease began to make its appearance, but in the great majority of reports received the disease was described as being very mild and as occurring only in the few late-wintering trees.

In general it can be said that the foliage and seed set in the old rubber was even better than last year and that the incidence of *Oidium Heveae* in the new leaf was practically nil up to the 10th March, and thereafter was mild and occurred only in the later-wintering trees.

The accompanying Table I shows the rainfall for the first five months of the year; the position of the dry period for each district can be noted.

TABLE I.

Rainfall in inches

District	Jan.	Feb.	March	April	May	Total for five months
Kuala Lumpur (Sel.)	5.77	7.27	12.41	13.67	14.49	53.61
Sitiawan (Pk.)	4.95	4.38	6.66	5.24	5.97	27.20
Port Dickson (N.S.)	6.54	0.98	6.01	6.75	12.38	32.66
Tampin (N.S.)	8.81	4.57	2.40	8.98	11.35	36.11
Malacca (S.S.)	3.07	2.24	8.27	5.69	8.79	28.06
Kluang (J)	5.94	7.25	8.13	11.06	10.79	43.17

TABLE II

Weather and Oidium Heveae in Malaya

	Weather	*Tree Growth*	*Incidence of Disease*
Nov.	November to March. N.E. Monsoon period. Strong steady North East trade winds causing rain at first followed by a	Growth slowing up preparatory to wintering.	
Dec.	period of fine dry weather in later January and February with change to rain when the wind stops about mid March.	In December the first leaves begin to change colour.	
Jan.		February to mid-March primary wintering of Hevea occurs as a result of the dry weather. Refoliation and growth quick if plenty of sunshine occurs each day. Wintering and refoliation later and growth slow if dull showery weather obtains delaying refoliation into April.	
Feb.			
March			Bright sunny weather, cold nights, hot days; unfavourable to fungus activity.
April	Ordinary very local Tropical Rainbelt type of weather. Morning precipitation and local afternoon thunderstorms.		
May			Primary attack of *Oidium* occurs aided by dull, cool, showery weather.
June	Period of South Western Monsoon. As experienced in Malaya is due to a frictional effect moving the atmosphere		Attack occurs immediately the N.E. wind stops blowing. Within 48 hours diseased leaves may be observed falling from the trees.
July	in conformity with the air currents over the Indian Ocean but to a smaller extent. Rain at first but dry in July and	Variable Secondary Wintering also due to drought. Second burst of shoot growth and new leaf especially in young trees.	
August	August.		Slight secondary attack of *Oidium* on new young leaves.
Sept.	Tropical Rainbelt type. Heavy local thunderstorms with bright intervals.		
Oct.			
Nov.	N.E. Monsoon begins. Heavier rains general.		

The chart for the year's weather given in Table II gives a rough indication of the influence of the monsoons on the seasonal changes in weather, their effect on the foliage of the rubber tree and the time and stage in which the leaf mildew may be expected to occur.

A summary of the report on this disease quoted from the *Journal* Vol. 7, No. 1, June 1936, reads as follows:—

"The general improvement in the health and vigour of the "foliage of rubber trees mentioned in the 1935 report was main- "tained throughout the 1936 refoliation season.

"Though heavy rains in January delayed the wintering or fall "of the old leaf by about four weeks the subsequent period of "drought—about six weeks—caused a severe wintering and a rapid "refoliation so that in many districts a new healthy, mature "foliage had developed before the dull showery weather, favourable "to the leaf mildew fungus *Oidium Heveae*, arrived in mid-March. "The central States were again the seat of greatest mildew activity "but it was in all cases less severe than has been recorded in the "past few years.

"Again, owing to lack of virulence of the mildew fungus under "drought conditions, the sulphur-dusting experiments carried out "in various parts of the country indicated no decisive improvements "in foliage or yield of rubber following such treatment."

Sulphur Dusts

Practically the only type of sulphur dust used during the last Oidium season was the "Cirrus Dust" developed by Imperial Chemical Industries, Ltd. as a result of collaboration with the Rubber Research Institute. It is now proved to give satisfactory dusting properties even after long storage in Malaya and, being produced in Java, it is as reasonable in price as can be expected. Several other proprietory dusts of American and European origin have been tested during the year, of which several are quite satisfactory for the purpose of disease control but cannot compete in price with the locally-manufactured Cirrus Dust.

In view of the occurrence of a few cases of *Phytophthora* leaf disease in the more northern districts of Malaya during the wet weather following refoliation, Imperial Chemical Industries, Ltd. are now engaged in the preparation of a sulphur-copper oxychloride dust which it is hoped will satisfactorily control both types of mildew. It is recognised that contamination of latex with copper salts is a very grave matter but it is hoped that the small amount of copper used and the care taken during the dusting will allow

of a satisfactory scheme of treatment for both mildews by this type of dust to be used.

Again the combination of lead arsenate dusts with sulphur facilitate the control of both fungus and insect pest of rubber tree foliage and is receiving attention.

Minor Leaf Diseases

During the dry weather experienced from February onwards, and even at the end of the year when heavy rains are normally the rule, the leaf spot fungi *Helminthosporium Heveae, Glocosporium Heveae, Colletotrichum* sp. and *Scolecotrichum* continued to give considerable trouble in nurseries and in young rubber in the field. It is obvious that these fungi are enabled to attack the young trees owing to their weakened condition due to lack of adequate water supplies to the young developing leaves. Temporary protection can be afforded the young plants by sulphur-dusting at intervals of 4 or 5 days during the period when they are acquiring a new storey of foliage.

Thrips sp.

The thrips pest of leaves of rubber trees was again prevalent on many estates in the west coastal districts of Malaya this year, but in very few cases was sulphur-dusting to check this pest really needed. At the Experiment Station, however, the attack was again rather severe in certain areas and sulphur-dusting was resorted to with considerable success.

Insect and Other Pests

Termites

Owing to shortage of staff no further experimental work was possible under this heading.

The position with regard to control remains practically unchanged. For general purposes the calcium cyanide—sodium silicofluoride method as devised and recommended by the Institute appears to give the most satisfactory results. Many planters, however, still prefer to use mercuric chloride. This chemical, being applied in aqueous solution, has some advantage over the poison-dusts for use during wet weather and in damp situations.

Interest was aroused towards the end of the year by the introduction on the local market of an alleged biological method of control, for which very remarkable claims are made. This method

is primarily designed for use in buildings, but could no doubt be modified if necessary for application in the field. Up to the present rigid secrecy has been observed by the company exploiting the method, and no comparative tests have yet been possible against standard methods of control. It is hoped, however, that facilities for such tests will be provided in the near future.

Cockchafer Pest (*Psilopholis grandis*)

The year was marked by a notable increase in the activity of the cockchafer pest. At the beginning of the year ten estates were known to be infested in various parts of the country, but during the months of June to December this number more than doubled, the greatest increase occurring in the district south-east of Seremban.

The pest was first reported to the Institute in June 1930, and its subsequent history can be followed by reference to Table III, which shows the numbers of new records received year by year since that date.

TABLE III

New Infestations recorded during the period 1930—1936

Year	Numbers of new Records	
	Estates	Localities
1930	1	1
1931	0	0
1932	1	1
1933	1	1
1934	2	2
1935	5	2
1936	11	6
Totals at end of 1936	21	13

The distribution of the estates and localities known to be infested at the end of 1936 is shown in Table IV.

TABLE IV

Distribution of Infested Areas at the end of 1936

State or Territory	Total Numbers of Records at the end of 1936	
	Estates	Localities
Negri Sembilan	7	1
Selangor	4	4
Perak	4	3
Kedah	2	1
Pahang	1	1
Johore	1	1
Malacca	1	1
Singapore	1	1
Totals for Malaya	21	13

The recent increase in the activity of the pest is not yet fully understood. If the increase is real it may be ascribed to a change in balance between the insect, its parasites and their hyperparasites, or to the evolution of methods of cultivation on rubber estates (*e.g.* "forestry" methods) which particularly favour the development of the insect in epidemic form. The increase may, however, be mainly illusory, the increase in the number of estate records being due to keener observation on the part of estate managers, or to the more general use of a ground cover in mature plantations, which greatly facilitates the detection of infested areas.

In order to obtain information on these and related problems a descriptive leaflet was circulated to estates at the end of the year asking for accurate information regarding the occurrence, history and distribution of the infested areas. There is still considerable doubt concerning the true economic status of the pest. It is hoped that the replies to the questionnaire will help to settle this controversial matter.

Thrips, Spiders and Mites

These pests have already been referred to under the heading "Minor Leaf Diseases."

Rodents

With the extension of the policy of replanting, increased trouble is being experienced with rodents, particularly rats. These vermin cause damage in all parts of the country, but are most numerous in the coastal districts where they breed profusely in the banks of rivers and drains, in padi fields, etc.

Rats tend to thrive abundantly in clearings where felled timber has been piled and left to rot on the land, and this method should therefore be avoided if possible in districts where the pest is known to be troublesome. Fortunately such districts are chiefly near the coast, where the land is flat, and the piling of timber has no particular value from the point of view of soil conservation.

The only sure method of preventing rat damage is to protect each young plant with a wire guard until the lower bark is sufficiently mature to be unpalatable. Some impression on the rat population can be made by trapping, hunting, and the use of poison baits, but considerable skill and experience is necessary if real success is to be obtained with these methods.

Diseases and Pests of Cover Plants

Pink Disease (*Corticium salmonicolor*) caused severe damage to woody cover plants in the wetter parts of the country. Leguminous bush covers are particularly susceptible to this disease, and should be avoided if possible where replanting old areas of rubber in known Pink Disease districts.

The Rust disease described in the *Annual Report* for 1935 was again in evidence, species of *Tephrosia* and *Crotalaria* being attacked in several widely-scattered districts. No further evidence was obtained regarding alternative hosts.

Cut-worms (larvae of various species of Noctuid moths) caused damage to bush covers in many parts of the country, both leguminous and "natural" covers being attacked. Some of the outbreaks were severe, but all were restricted to small areas and were sporadic in character. Milder outbreaks yielded readily to lead arsenate and kerosene emulsion sprays. Severe attacks were more difficult to control, though in all such cases brought to the notice of the Institute the pest eventually dispersed, presumably in response to some change in local environmental conditions.

Mealy-bugs (*Pseudococcus* spp) were more in evidence than usual, and caused damage on all types of planted covers. These insects are difficult to control on account of their waxy covering, and it is fortunate that they confine their attentions chiefly to the ground cover.

Epidemic outbreaks of Nettle-grubs (larvae of various species of *Limacodidae*) were reported from two estates in North Perak. Both areas were under a heavy cover of grass, and control was obtained by spraying the grass with sodium arsenite, to destroy both the grubs and the protecting vegetation.

Bacteriology of Soils

Throughout the year investigations have continued in order to find the changes in numbers of bacteria which may take place in Malayan soils following the application of various types of manures, and also the adoption of natural forest covers after a long period of clean-weeding.

The seasonal fluctuation in numbers has again been verified on a number of the experimental plots, while the effect of manures can also be noticed in the results so far obtained.

In general terms the results to-date indicate

(*a*) a very wet season or a very dry one has a depressing effect on bacterial numbers;

(*b*) a medium dry season has a tendency to increase the bacterial population of soils to peak levels;

(*c*) the lowest numbers of bacteria per gramme of soil are found during the very wet weather of December and January and the dry month February, and to a less extent March;

(*d*) maximum peaks are reached about May or June and again in September or October after periods of continued medium or light rains with plenty of sunshine;

(*e*) complete inorganic fertilisers show generally a considerable increase in bacterial numbers with the seasonal increases accentuated;

(*f*) complete organic fertilisers have given varying results, including slight increases over the two years and others slight decreases over the same period with less marked seasonal variations. Further experiments will be required before a definite statement regarding the effect of organic manures can be made;

(*g*) the adoption of natural covers or forestry methods shows a general improvement in bacterial population but not so marked as

that of the inorganic fertiliser plots. In regard to the microfungal population, which was only occasionally determined, little can be said except that general increases occur simultaneously with the bacterial increases.

It is intended to continue these soils-bacterial counts until August or September 1937, when 2½ years' records will be available, including three sets of each of the seasonal peak counts of which only two are now available.

Fungicide Tests

These tests are carried out to determine the suitability of various proprietory fungicides in control of Mouldy Rot. Four preparations were tested early in the year and a further four towards the end of the year. Of these eight preparations tested two only have been passed and in due course will be gazetted to the official White List of fungicide for use in control of Mouldy Rot. These are (1) Durycolium, a locally-made dark, waterproof fungicide for use neat on the panels, (2) White Septol—a water-miscible fungicide used at a strength of 5 to 10 per cent. in water every tapping day. A third product gave fair results, but the proprietors desire to modify its composition to obtain better results before placing it upon the White List.

In addition to the above official tests it has been necessary to make a modified test of several preparations of various composition which find a moderate sale in village shops among small-holders. Almost invariably these preparations are not only rather expensive compared to the recognised fungicides on the White List, but may frequently cause severe bark burning when applied to the deeply-tapped bark usually found on native small-holdings.

Enquiries have also been dealt with concerning the use of tar-oil fungicides or chemical poisons in paints and distempers in order to prevent the growth of bark mould in the surface after application to wood, metal or brick buildings and structures, which frequently causes decorational disfigurement of building interiors in the tropics.

Replanting and Diseases of Hevea

Towards the end of 1935 a questionnaire was circulated to estates known to have enquired at the Rubber Research Institute on the subject of replanting old areas of rubber. This questionnaire contained some 21 questions on the various operations to be observed before, during and after replanting. Of the 96 estates circularised some 46 replies were obtained and the answers to the various questions analysed.

Advisory Work

As a result of the return of prosperity to the industry there was a heavy increase in advisory work, most estates making a determined effort to repair the damage caused by unavoidable neglect of plant sanitation during the period of economic depression.

An analysis of correspondence is appended to the Report of the Director. Other details are as follows:—

Specimens Examined

Leaves	207
Roots	41
Cover Plants	17
Bark	22
Stumps	4
Branches	21
Seedlings	24
Fructifications	12
Insects	25
Fungicides and Insecticides	8
Soil	325
Total	706

Visits to Estates

Visits to Estates other than the Experiment Station	98
Visits to Experiment Station	17
Total	115

Interviews ... 79

Lectures

On November 9th a paper on "Root Disease Control in relation to Replanting" by R. P. N. Napper was read before the Nilai-Labu branch of the Incorporated Society of Planters.

PUBLICATIONS

(1) Report of the 1936 Outbreak of *Oidium Heveae*, by F. Beeley
R.R.I. Journal, Vol. 7, No. 1

(2) Official Grading of Proprietory Fungicides for Treatment of Mouldy Rot Disease of Rubber Trees, by F. Beeley
R.R.I. Journal, Vol 7, No. 1

(3) An abridged version of (2) was published in the *Malayan Agricultural Journal*, Vol. 24, No. 6.

TOURS

The following extended tours were made during the year:—

By	*To*	*In connection with*
F. Beeley	Negri Sembilan, Malacca and Johore	Oidium leaf disease
—do—	Perak and Province Wellesley	Oidium leaf disease
—do—	Aerial Survey of Districts west of the main range	
R. P. N. Napper	South Kedah	Root Disease
—do—	Negri Sembilan and Johore	Cockchafers, Root Disease and Replanting
—do—	South, Central and Lower Perak	Root Disease and Replanting.

F. BEELEY,
Pathologist.

R. P. N. NAPPER,
Pathologist.

ANNUAL REPORT

CHEMICAL DIVISION

Staff and General

From the beginning until almost the end of the year the full complement of research officers was available. Mr. Moore returned from long leave during May 1936 and resumed the duties of advisory officer.

The fire which took place on 24th September 1936 destroyed the laboratories and the factory of the Chemical Division and a mass of unpublished research data of which some dated back several years. The result is that for more than one quarter of the year, research work has been almost at a standstill, and when it becomes possible to resume, a great deal of repetition work will be necessary.

Latex Constituents

Dr. Roberts has continued his studies on the constituents of latex, and a paper, in which the general nature of a number of new latex constituents and combinations of known constituents are described, has been published by him during the year. These comprise:—

(a) the ammonium salt of a ketonic acid

(b) an ester of the ketonic acid

(c) a fatty acid complex containing fatty acids in combination with a group of higher alcohols, a glucoside of the alcohols and small amounts of a sesquiterpene,

(d) a complex containing a rubber-like substance in combination with a sulphur acid and other acids; this has been named the "sulphur complex" of latex.

(e) a complex containing protein, sugar, quebrachitol and mineral salts; this has been termed the "protein complex" of latex.

It is significant that the bulk of the fatty acids of fresh latex should now have been shown to occur in chemical combination and not free or as soluble metallic soaps as has been freely assumed in the past. That the true and cyclic "sugars" of latex should also have been shown to occur in a chemically bound condition, is a

further not unimportant finding. From the point of view of explaining in chemical terms the changes which take place in the properties of ammoniated latex on storage, the discovery of the various latex complexes is of great value and without foreshadowing unduly results which are yet unpublished, it can be said that some chemical information on this problem has been obtained during the year.

Regular day-to-day analyses of latex from the same estate source have indicated that weather conditions play a very important part in determining variation in the composition of latex; fairly prolonged spells of dry or wet weather cause pronounced variation in the amounts of certain of the constituents, and this encourages the hope that it may later become possible to obtain a picture of the chemical reaction of Hevea to weather conditions.

A more precise chemical characterisation of the various new free and bound constituents has been commenced but is yet by no means complete. Progress to date is encouraging and it is by no means improbable that it may lead eventually to an explanation of the mechanism of the natural synthesis of caoutchouc.

Latex Preservation

General

In past reports the prediction has been made that only those estates or groups which were in a position to instal bulking tanks large enough to permit them to sell from bulks of several thousands of gallons would eventually retain their hold on the market for normal latex; by the close of the year further proof of the truth of this prediction was available. A number of the estates which previously sold unconcentrated latex from small bulks no longer have a market. On the other hand one new large-scale estate bulking outfit has been brought into commission and there are strong indications that similar equipment providing for bulks of the order of 10,000 gallons will very shortly be erected by three other estates.

Shipment of normal latex by steamer tank from large shore bulks at Port Swettenham and of concentrated latex from similar shore bulks at Singapore has continued during the year.

Colour of Preserved Latex and Treatment of Shipment Vessels

(i) *Colour of Latex*

The observation that a very slightly discoloured preserved latex gave on coagulation with a mineral acid in presence of potassium ferrocyanide a coagulum having a strong blue colour, led to some preliminary experiments on the possibility of using

some such test as a criterion of degree of discolouration. It was felt that it might perhaps be possible to use it as the basis of a method of judging which would be less uncertain than the present method, which is by the eye on the latex itself. At the close of the year, however, a satisfactory technique had not eventuated.

(ii) *Treatment of Shipment Vessels*

Attention has been given to the latex-zinc oxide filming technique with particular reference to the reduction in latex stability which attends its use. It has been amply confirmed by stability tests, carried out at intervals on latex samples stored in filmed and un-filmed containers, that the early statements made by buyers were well-founded; the film does cause a reduction in stability. The extent of this reduction varies considerably from sample to sample. It may sometimes, but not always, be a very serious one. The reason for the variation in effect is not yet known. Experiments have been made with latex films containing zinc oxide together with other ingredients chosen to lessen the adverse effect on stability while at the same time not impairing the adhesiveness of the film. Comparative stability tests against latex stored in contact with the simple latex-zinc oxide film indicated that one of the modified films was at least partially successful from the standpoint of stability. One producer with the generous approval of his buyer has collaborated with us in a shipment trial with drums treated with the modified film. Reports on the "out-turn" of the shipment are not yet available. It is expected however that the film will be judged to be slightly but not sufficiently improved.

Towards the close of the year a new bituminous preparation was made available to us by our London colleagues. This material consisted of a blended bitumen in a volatile non-inflammable solvent. It therefore suggested itself as being suitable for use in second-hand drums. Laboratory storage tests with treated metal strips in freshly-ammoniated latex, and also in latex partially putrefied in presence of the strips before ammoniation and storage, were encouraging. Discolouration of the latex did not occur during five weeks storage and the film itself was in good condition at the end of that period. Small-scale shipment trials are about to be made by the courtesy of an estate. Recent advices indicate, however, that the price of the preparation may prove to be higher than producers could afford to pay.

Putrefactive Odour in Preserved Latex

The "boric acid test," which is believed to be of American origin and which consists in treating the latex wth an equal volume

of a saturated solution of boric acid and judging the odour immediately by the nose, has been applied with fair success to a number of laboratory and estate samples. The normal ammoniacal smell is overcome by the use of the boric acid and judgment of putrefactive odour is facilitated. Throughout the year estates which have suffered complaints against odour have been advised to employ a final ammonia content of not less than 0.75 per cent. and to guard against excessive bacterial development and incipient putrefaction in the field by the application of small amounts of a 10 per cent. ammonia solution in the tappers' buckets. As a means of preventing the establishment of ammonia-resistant strains of bacteria in bulking and storage tanks and in the factory itself, regular disinfection of vessels and floors with a disinfectant of the cresylic acid type, has in such cases been advised also.

Stability of Preserved Latex

(i) *Technique of Stirring-stability Test.*

The stirring-stability apparatus devised in the laboratories of the London Advisory Committee and supplied to us towards the end of 1935, has been in continuous use. It differs from the type of apparatus in most common use in America, in that it employs a comparatively slow moving paddle (600 r.p.m.) and stirring is carried out in presence of comparatively large amounts of added zinc oxide. When used on latex which has been preserved for several weeks, the added zinc oxide produces a sharp coagulation which can be used as an accurate end-point. Stability can then be measured as the number of revolutions of the paddle required to reach the coagulation end-point. It was early found at the Institute that with freshly-ammoniated latex, stirring in presence of zinc oxide does not produce a rapid coagulation but a progressive thickening. After some experimentation it was found that if an amount of zinc oxide of the order of 27 per cent on the weight of latex were employed, and if the level of the upper surface of the latex were adjusted to coincide with the upper edges of the paddle blades, the progressive increase in viscosity could be used as a good end-point; the vortex produced by the paddle becomes progressively shallower as thickening proceeds. The moment when the viscosity is such that the paddle can no longer create a vortex, and the latex closes over the paddle shaft, is readily discernible and forms a good end-point. Results can usually be repeated within 50 paddle revolutions in duplicate tests. It is interesting to note that with old ammoniated latex, the "coagulation end-point" is reached within 150 revolutions after the "viscosity end-point" is passed.

In presence of this amount of zinc oxide it has been found that the test is sensitive to (a) concentration of initial latex, (b) amount of ammonia present, (c) type of zinc oxide, (d) temperature of testing.

Of these, temperature variations produce the most striking variations. The magnitude of this factor is illustrated by a typical case in which a latex sample at 10°C required 3,200 revolutions to reach the viscosity end-point, but reached it in 1,080 revolutions when, with all other testing conditions identical, the temperature was raised to 40°C.

The testing procedure at present adopted arbitrarily at the Institute to suit conditions in the tropics and the peculiar characteristics of freshly-ammoniated latex, is to dilute the latex or concentrated latex to a dry rubber content of 30 per cent, adjust the ammonia content to 0.7 per cent, sieve through a 100-mesh sieve and then dust into it—after stirring has commenced—27 per cent by weight of zinc oxide calculated on the weight of diluted latex. The time taken to introduce the zinc oxide is approximately 30 seconds. Stirring continues at 600 revolutions per minute until the viscosity end-point is reached. The temperature of the latex when taken for testing is 32°C (90°F) approximately.

The testing technique described above has been applied to preliminary studies on (a) the effect of storage on the stability of latex, (b) seasonal variations in stability, and interesting data were obtained of which the following is a brief summary:—

(ii) *The Effect of Storage on Stability*

It was found that when latex is stored its stirring-stability in presence of zinc oxide shows a progressive fall during a period of five to six weeks, and thereafter remains roughly constant. The fall is usually most marked in the first few days of storage. In a typical case of a fairly stable latex, the stability fell from 96,000 to 27,000 revolutions in a period of seven days; in another case it fell from 117,000 to 8,000 revolutions during the first week and reached an approximately constant value of 1,700 revolutions after 30—40 days. Test results on various latices by the officers of the London Advisory Committee show values of the same order, namely 1,000—2,000 revolutions for old ammoniated latex.

The type of storage container also appears to have an effect on the rate of change of stability during storage. In all the tests so far made, latex in glass containers showed a more rapid fall in stability than the same latex stored in closed iron or tinned-iron vessels. The effect of light has not yet been fully explored in this connection but there are indications that it may accelerate the rate of fall of stability.

The reasons for the fall in stability on storage are not yet known. Tests have indicated that the changes are not reflected in pronounced changes in viscosity, surface tension or acetone-extract of the total solids; the acid-value of the acetone-extract does, however, tend to increase on storage, but whether there is a real connection between this and the stability remains to be seen.

The implication of these results to the producer is that haphazard stirring-stability tests made on newly-preserved latex may be quite meaningless and even misleading. Until a great deal more experience has been gained, it will be quite impossible to make predictions as to ultimate stability from tests made soon after preservation.

(iii) *Seasonal Variation in Stability*

Only a few preliminary tests were possible during the year but these gave indications that latex harvested during the wintering season shows a more pronounced fall in stability on storage than that harvested when refoliation is nearly complete. These results were not unexpected, and the precise reason for them is obscure.

(iv) *Sieving-stability Test*

The sieving-stability apparatus developed by the Dunlop Rubber Co. was used in the storage experiments described above, and the results were compared with those obtained with the stirring-stability equipment. The sieving apparatus provides a ready means of detecting the degree of incipient agglomeration which takes place in latex and which has a pronounced bearing on its stability during certain manufacturing processes. It was found that the pronounced storage changes which were indicated by the stirring-stability apparatus were not reflected in the results obtained by the sieving method and it therefore seems probable that the storage changes are not due in great measure to the formation of aggregates of a size large enough to be removed by sieving.

Viscosity and Surface Tension of Latex

(i) *Viscosity*

By the third quarter of the year viscosity determinations by the Höppler Viscometer had been made on several hundred samples of normal preserved latex, centrifugal concentrates, filtration concentrates, and filtration serum, and material was available for a D.R.C. viscosity relationship covering a D.R.C. range from 0—70 per cent. The greater part of the data was destroyed by fire. The striking increase in viscosity which takes place as concentra-

tion proceeds is well illustrated by the following typical table of values from a filtration experiment:—

D.R.C. per cent	η centipoises
34.8	4.74
44.9	9.08
55.9	23.72
60.9	51.90
66.2	159.50
70.8	2160.00

The rapid increase in viscosity which occurs at dry-rubber-contents in excess of 60 per cent, has an important bearing on the design and operation of centrifugal machines for latex concentration.

(ii) *Surface Tension*

Surface tension measurements with the Du Nüoy apparatus were made on a long series of mixtures of ammoniated latex with its own filtered serum and filtration concentrate. Such mixtures covered the D.R.C. range from 0—70 per cent and surface tension measurements were made over the whole range. The values obtained were remarkably constant over the range 0—62 per cent and all lay between 43.7 and 44.9 dynes/cm. In the D.R.C. zone 66—70 per cent the progressively higher values 47.3—64.4 dynes/cm. were obtained, but these are open to question on account of the possibility of surface skinning during testing.

It seems clear that although there is a connection between dry-rubber-content and viscosity, there is no correlation between dry-rubber-content and surface tension.

Alternative Methods of Preservation

(i) *Sodium Arsenite*

Small-scale shipment trial lots of latex preserved with (a) 0.1 per cent ammonia plus 0.3 per cent sodium arsenite by weight of the latex, and (b) 0.1 per cent ammonia plus 0.5 per cent sodium arsenite, were forwarded to and were tested by our colleagues in London. The latex travelled well and had normal properties except in respect of stability which, by the stirring-stability test, was found to be much higher than that of normal ammonia-preserved latex.

The fear that the latex itself, and articles prepared from it, might prove poisonous to workers and others will almost certainly prevent users from becoming interested in obtaining supplies of it.

(ii) *Paradichlorbenzene*

This substance when applied to fresh latex in amounts ranging from 0.05 to 0.5 per cent by weight on the latex, both in absence and presence of 0.1 per cent ammonia, failed to preserve latex in a fluid condition.

(iii) *Benzoyl peroxide*

When applied to fresh latex as for paradichlorbenzene above, benzoyl peroxide failed as a preservative.

(iv) *"Acid" Latex*

Trial samples of acid latex and "stabilised" acid latex have been forwarded to our London colleagues for test. The samples travelled fairly well but not without some coagulation in transit. They were found to be extremely unstable to chemical manipulation and it may now prove that as so prepared they have doubtful commercial value.

(v) *Chlorine and Latex*

Attempts were made to sterilise and preserve latex by mild chlorination, but were unsuccessful. This was probably due to reaction of the chlorine with the caoutchouc and its removal from solution in the serum before sterilisation could be accomplished.

(vi) *Ethylene diamine*

This substance is available in a commercial form having a purity of 60—70 per cent. When applied to latex in amounts between 0.75 and 1.0 per cent on the weight of latex, fluidity was maintained for long periods. Its cost would probably outweigh in practice the advantage of absence of a strong ammoniacal odour.

Concentration of Latex

Concentration by Creaming

During the year seeds from a number of locally-occurring plants have been tested as possible creaming agents for latex. Seeds from certain Cassia species were found to be quite effective, and gave creams of D.R.C. 59 per cent in 48 hours. This finding

was considered important but it transpired unfortunately that the discovery had been made earlier by other investigators to whom a patent was granted shortly afterwards.

The search for useful "seed-creamers" has, however, continued and other effective creamers have been found, of which one has special commercial promise. Shipment trials of cream prepared by its use have confirmed its value.

Some success has attended the continued efforts to induce creaming by the use of substances other than vegetable or animal mucilages. One such substance has been found which gives high D.R.C. creams but its cost, coupled with the necessity of employing it at high concentration, may render it uneconomic. Further work with this and allied substances is proceeding.

During the year a large range of methylated starches and hemicellulose products prepared by the scientific officers of the London Advisory Committee were received for creaming trial in freshly-preserved latex. The majority proved, unfortunately, to be less efficient than Tragon A which was taken as a basis of reference. One series of products had however special interest and were it not for the fact that such products demand rather special storage conditions in the tropics, they would have been classed as having commercial possibilities.

Concentration by Centrifuging

Tests were continued during the first half of the year with the centrifugal machine mentioned in the last report. The machine was then returned to the makers. It is hoped that during the coming year machines of other makes will become available to us for efficiency tests.

Particular attention was directed to improving the operation of the machine by various treatments of the latex before centrifuging; protection has been sought for one such treatment.

It was also sought to develop a process which would, while providing a satisfactory concentrate, yield at the same time a skim latex from which the rubber could be removed with greater ease than is the case with skim latices from ammonia-treated latex. No great measure of success was achieved; in most cases, where a readily-manipulated skim resulted, trouble was experienced through rapid choking of the machine. Choking involves dismantling for cleaning, and if a process is to be satisfactory, time losses through this cause should be minimum. Treatments which did not result in choking usually gave skim fractions which did not coagulate with the ease desired.

Trials were also made with latex which had been dosed with creaming agents before centrifuging. In all cases, where centrifuging took place within six hours of the addition of the creaming agents, the resultant centrifugal concentrates creamed up further on standing, and the products were deemed unsatisfactory for this reason.

Concentration by Evaporation

Towards the middle of the year an experimental plant designed by the officers of the London Advisory Committee was received and installed at the Institute.

It has been found possible with this machine to concentrate ammoniated latex to a dry-rubber-content of the order of 68 per cent without the aid of added protective colloids. There is, however, a very considerable ammonia loss and it is necessary to make good the loss at intervals as concentration proceeds.

The hourly throughput of the machine is small and, even with larger equipments of this design, it would probably be found necessary for economical working to use as a starting material, a latex which had previously been concentrated by creaming or centrifuging to a dry rubber content of the order of 55 per cent. Evaporates have been prepared from such creams and a small trial consignment was reported on favourably in England. It is obvious that a 70 per cent evaporate prepared from a cream has a much lower proportion of non-rubber constituents than are present in concentrates of similar dry-rubber-content prepared from stabilised whole field latex. A comparatively low proportion of "non-rubbers" is a desirable feature in some manufacturing processes. The stability of the high D.R.C. evaporated-creams containing ammonia as the sole preservative is very satisfactory. A consignment of 90 gallons of such a concentrate was despatched towards the end of the year to our London colleagues for thorough tests.

The destruction of testing apparatus and the disorganisation caused by the fire, has prevented the commencement of a long series of closely controlled experiments which had been planned.

Concentration by Filtration

Concentrates have been prepared in locally-constructed porous earthenware vessels from normal ammoniated latex and also from creamed latex. Filtration was slow and fairly frequent and thorough stirring was necessary to prevent the formation of too thick a layer of buttery concentrate on the walls of the filter vessels. It was found possible to reach a dry rubber content of 70 per cent by this means.

An interesting comparison was made between high D.R.C. concentrates prepared from the same creamed latex by filtration and by evaporation. The final concentrates both contained approximately 68 per cent. dry rubber, but the filtered cream was much less viscous than its evaporated counterpart. The stirring-stability of the evaporated cream was found, however, by our London colleagues to be much superior to that of the filtration concentrate. This was not unexpected, in view of the fact that for obvious reasons the high D.R.C. filtration concentrate contains an even lower proportion of non-rubber constituents than both the original cream and the evaporated cream prepared from it.

Further experiments await a new supply of filtration vessels. Our London colleagues are kindly investigating the possibility of obtaining more suitable vessels than those available locally.

Latex Coagulants

Formic and acetic acids are in almost universal use on estates, but the use of sulphuric acid on small-holdings is prevalent in some parts of the country. During the year a paper has been published in which it has been shown that on one-third of the total acreage of small-holdings, sulphuric acid is by far the most favoured coagulant. Its chief appeal to the small-holders is its price. Formic and acetic acids cannot be marketed in small bottles at a price which can compete with it and enterprising Asiatic bottlers have made full use of the fact.

The Institute's Asiatic Rubber Instructors in all parts of the country are endeavouring to persuade small-holders to the use of formic acid. All the Rubber Instructors have recently been equipped with field testing outfits enabling them to make qualitative tests in presence of the small-holders themselves. This may in some cases add weight to the persuasion. The reports of the field testing will also keep headquarters constantly advised of the prevailing state of affairs in the various districts.

Copper Contamination of Latex

During the year a paper was published by Mr. Hastings and Mr. Sekar describing experiments which illustrate the dangers attendant upon the use of brass sieves for straining latex. A warning had, however, been issued earlier. It is pleasing to record that by the end of 1936 supplies of monel metal gauze suitable for use in straining fresh field latex had not only become available in Malaya but were finding a ready sale to estates. One large supplier of estate utensils has also ceased to use the brass nuts and bolts which had been the customary fitment on aluminium

troughs, chutes and sieves. These had been used because aluminium nuts and bolts do not give satisfactory service; monel metal bolts and nuts are now fitted by this firm to all such utensils.

In the paper under reference, attention has been drawn to the fact that fresh latex has a small but definite natural copper content. This was an unexpected finding which will receive further attention.

Some users of rubber are anxious to obtain raw rubber which can be guaranteed to be copper- and manganese-free. Because of the natural copper content of latex complete freedom from copper could not be guaranteed by the estate, but there are now several producers who are in a position to guarantee that their product is uncontaminated by extraneous copper.

Preparation of Modified Rubbers

Rubber having the Property of Low Water-absorption

Favourable reports were received during the year on small samples of rubber prepared by Mr. Hastings by enzymic digestion of latex before coagulation.

As a result, a consignment large enough for a works test by a manufacturer was prepared by papain digestion during storage of the latex in an alkaline condition, followed by coagulation and soaking, before machining into crepe. By the courtesy of a well-known firm of cable makers, works tests are being carried out on the rubber and there is some reason to expect that the results will be favourable.

The technique of manufacture of this special rubber is troublesome and it is considered important that the work be continued with the object of discovering a simpler but equally effective procedure. Some estates would be deterred by the prospect of ammoniation and subsequent coagulation with a coagulant to which they are unaccustomed. Others have not facilities for soaking large quantities of wet rubber in running water. Further, not all estates have drying space sufficient for the drying of crepe rubber of this type, which possesses the undesirable feature of being very slow drying and very sensitive to sunlight. Light has the effect of causing extreme stickiness and even liquid flow.

The normal smoked sheet product from a large number of estates was tested by Mr. Hastings for water-absorption, in order to discover the general level which prevails for this property. All the rubbers save one gave results which were far too high for them to be of special interest to cable makers. The single exception,

though much less absorbent than its fellows, could still not be classed as suitable for cable work. It is significant that the estate from which this sample came was the only one on which soaking of the machined sheet for a period longer than a few minutes is the routine procedure. This confirms early findings made at the Institute, which were that soaking of the wet sheet for a period of half to one hour reduces its water-absorption very appreciably.

Soft Rubber

The work which was in progress last year on the influence of variations in normal factory technique on the plasticity of the final product, has been prosecuted actively by Mr. Hastings. It has been found that variations in dilution of the latex, in the amount of coagulant, degree of machining and amount of soaking, have but little effect on plasticity. The wide variations in plasticity which are encountered in commercial rubbers must therefore be due either to inherent differences in the rubber-like constituents of latex or to drying conditions, or both; the water-soluble non-caoutchouc constituents clearly have little effect on this property, and normal estate manipulations at the latex and coagulum stages cannot be varied to give a very soft rubber.

Complaints that light-coloured smoked sheet was usually hard and dark-coloured sheet soft, led to an examination of the initial hardness of the product of approximately one hundred estates. It was sought not only to obtain confirmation or otherwise of the implied correlation between colour and hardness, but also to obtain clues as to the part which drying and/or smoking plays in determining plasticity. The rubbers tested covered a wide range of colour shades, from colours almost indistinguishable from that of air-dried sheet, to a heavy brownish-black. No significant correlation was found between shade of colour and initial hardness; many of the lightest-coloured sheets were very soft and many of the dark sheets hard. It would appear that the amount of deposited smoke-bodies is not the controlling factor.

There have been abundant indications that the nature of the tree population has a great effect on the plasticity of the product, and it will probably be found that the rubber-like constituents of latex, whether *per se*, or by their greater or smaller tendency to oxidation, are responsible for the major natural variations in plasticity.

The fire at the Institute deferred the continuation of work on some of the promising lines which had been indicated by the work on low water-absorption rubber and which might result in techniques for the manufacture of unnaturally soft rubbers.

Drying and Smoking Conditions and their Effect on the Ageing Properties of Rubber

In view of Mr. Hastings' published findings that hot-air dried sheet shows inferior bomb-ageing properties to smoked sheet as indicated by tests on simple rubber-sulphur mixes, close attention has been paid during the year to drying conditions as affecting ageing. In this connection very helpful collaboration has taken place between the Institute and the research department of Goodyear Plantations Ltd., Sumatra. Samples of hot-air dried and smoked sheet from the same latex have been prepared, exchanged and tested by both parties. The results obtained in the Institute on bomb-aged simple rubber-sulphur mixes indicated the superiority of smoked sheet samples; the Sumatran tests on the other hand which are on oven-aged accelerated mixes did not indicate this superiority. The reason for the differences is obscure. An explanation may be forthcoming when a very complete range of tests now being made at the Akron headquarters of the Goodyear Company have been completed.

The more important findings which have so far emerged from Mr. Hastings' exploration of the effects of drying are:—

(a) that the time and temperature of smoking, so long as they remain within reasonable limits, and provided that smoke is present throughout the whole period of drying, have little effect on the ageing properties of smoked sheet;

(b) the ageing properties of an adequately smoked sheet, as indicated by the R.R.I. testing methods, are impaired if after drying in smoke it is subsequently heated again for several hours in smokeless hot air.

A continuation of this work awaits the arrival of new testing equipment.

Clone Rubber

Pilmoor Clones

Vulcanisation, ageing and plasticity tests were carried out monthly during the first three quarters of the year. As in previous years two of the clones continued to give rubber which cured slightly faster than that from their fellows.

Ageing results were satisfactory for all the clones.

Plasticity determinations revealed the interesting observation that the rubber from one of the clones is persistently softer than that from the other three under test. In tests made over a typical

month on individual samples from alternate-daily tapping, the "D_{30} value" of rubber from clone B 16 was below 1.40 mm. on ten of the thirteen tapping days, whereas in the case of the other three clones the "D_{30} value" exceeded 1.40 mm. on twelve of the thirteen days.

Day-to-day variations in hardness were observed for all clones.

Mr. Hastings intended to publish a concluding paper on the Pilmoor rubber tests, but all the data were destroyed by fire.

Clones in Block 5 at the R.R.I. Experiment Station

This block was brought into tapping on 1st January 1936 and rubber from it was obtained and tested regularly. The clones planted in this block are:—A.V.R.O.S. 49, B.D. 5, A.V.R.O.S. 50, P.B. 186, B. 84, A.V.R.O.S. 152, P.B. 23, A. 44 and Tj. 1. During the first six months the amount of good quality rubber obtained from clone A.V.R.O.S. 49 was negligible owing to severe premature coagulation in the cups and even on the cuts. No vulcanisation tests were therefore possible on rubber from this clone.

The most notable observation made on the rubbers tested during these early months was that the rubber from Clone P.B. 186 was invariably much softer than that from any of the other clones. It will be of great interest to determine if this desirable feature persists.

All records of the tests made on these rubbers were destroyed by fire.

The Drying of Rubber

During the year close attention has been paid to the drying of rubber, and a long series of experiments has been completed by Mr. Piddlesden. These experiments were designed to provide a fairly complete picture of the mechanism involved and to disclose the controlling factors. For lack of a complete understanding of the manner in which rubber dries, it has previously been possible only to speculate on the probable success or otherwise of new forms of drying equipment. The studies which have so far been made indicate that there is virtually nothing to be gained from the use of elaborate dryers of the types employing forced circulation of air and that the more modern types of smoke-house, whether considered from the view point of capital or working costs, are unlikely to be superseded by others differing radically in principle.

The tests were carried out for the most part in small thermostatically-controlled cabinets at the Institute; these were also equipped to provide forced or natural air circula-

tion at will. Larger-scale trials were also carried out at the R.R.I. Experiment Station in the oil-fired forced-circulation dryer, to which reference was made in the last report. It has been established beyond doubt that the drying can be divided roughly into two stages, of which the first is short and of the order of a few hours only; the second is long. The first stage is a surface evaporation phenomenon and continues until all free surface moisture has been carried off and the sheet, although still containing rather less than 10 per cent moisture, is comparatively dry to the touch. With good natural ventilation the end of this stage is reached in four or five hours. Forced circulation assists the evaporation of water from the surface and may halve the time taken in this short stage of the drying. When the free water has been removed during this surface-evaporation or "constant rate period", the rate of removal of the remaining moisture then begins to be governed by the rate at which it can diffuse from the body of the rubber to its surface. The rate of diffusion is comparatively slow and the surrounding air even under poor conditions of ventilation can carry off this moisture with ease. Forced circulation now has no real advantage; apart from the fact that it ensures uniform temperature conditions throughout the house, by mixing the air and destroying hot pockets, it is useless, because it can do nothing to increase the rate of arrival of moisture at the surface by diffusion, and the water so delivered would in any case be carried off easily by natural ventilation. Save for the first few hours, diffusion is in control throughout the whole of the drying-time. This finding means that if quicker drying is sought, the total time can only be shortened by (a) reducing the thickness of the sheet and (b) raising the temperature, thereby increasing the rate of diffusion.

The total time occupied in drying a sheet of rubber at a given temperature has been shown to be proportional to the square of its thickness, so that if the thickness be $\frac{1}{8}$" the drying period will be four times that of a sheet measuring 1/16" in thickness. Theory would demand proportionality during the period when diffusion is controlling the drying, and not in the early stages which are controlled by surface evaporation. At first sight it would appear therefore that the experimental results do not accord with theory. It has already been indicated, however, that the first stage is comparatively short, and it further transpires that when rubber is rolled into sheets the act of rolling brings about a condition in which the total initial moisture, less 10 per cent, is also proportional to the square of the thickness. It thus follows that this proportionality holds for the whole drying period. Van Harpen had reached the same broad general conclusion earlier, but without attempting the detailed analysis which has now been made.

The results obtained have a direct bearing on smoke-house design and operation. They indicate particularly

(a) that there is little advantage in the employment of forced air circulation during drying; the very slight advantage to be expected would not justify its capital and operation costs;

(b) the design of a smoke-house should be such that good natural ventilation can be ensured during the first hours of drying without undue interference with the ventilation and temperature conditions applied to rubber in other parts of the house; it should permit thereafter of drying under much reduced conditions of ventilation, thereby avoiding wastage of heated and still unsaturated air;

(c) the design should permit of temperature regulation so that higher temperature can be applied when the sheet is dry enough to permit this without damage;

(d) for rapid drying the rubber should be thin and of the order of 1/10".

A full description of this work will shortly be published by Mr. Piddlesden together with a description of the "Subur" types of smoke-house, which fulfil in great measure the desiderata set out above.

There are, however, certain directions in which present-day smoke-houses would appear to be capable of improvement, and it is hoped that in the coming year an experimental but moderately large house, of which the design should lend itself to greater heat economy, will be erected and tested by the Institute.

Sheeting Batteries

A new type of battery, employing six pairs of rolls arranged in two groups each having three closely-connected pairs, is making its appearance on the market. It demands the employment of three operatives; one feeds the coagulum, another who stands between the two banks of machines withdraws the partly-machined rubber from the first bank and feeds it into the second, while the third worker takes off the final marked sheet. At the end of the year only two of these batteries were in regular operation. These are the original models built by the patentee Mr. Reginato. A number of estates are about to instal these batteries which are marketed under the style of the "Guthrie R Type".

Service Trials of Rubber Flooring

The trial of rubber floorings inaugurated by the Rubber Growers' Association and carried out by the Federated Malay

States Railways in collaboration with the Institute, is now being brought to a close. The trial pieces are being removed from the rakes of coaches, a few at a time, when conditions permit a coach or coaches to be taken out of service temporarily. The samples, of which most show signs of deterioration after over three years' wear and exposure to tropical weather conditions, will be subjected to final tests in London.

Advisory Work and Routine Chemical Examinations

The volume of advisory work has again been considerable. Many enquiries have been received on smoke-house design and a revised pamphlet on the Subur Type smoke-house was issued during the year. An enlarged pamphlet including details of the modified house suitable for waterlogged sites will appear during the coming year.

Collaboration with Allied and other Organisations.

Close and helpful collaboration has been maintained with the scientific officers of the London Advisory Committee for Rubber Research, on all matters concerning latex and rubber. Many samples have been tested by these officers on our behalf and their help in consulting users and other authorities on the merits of various trial samples and in drafting and negotiating patent applications, is gratefully acknowledged.

The Institute has been in constant touch with the Crude Rubber and Latex Sub-Committee of the American Chemical Society (Rubber Division). Through this Committee it is now possible to obtain authoritative American opinion on all rubber matters, and during the year views have been exchanged and very helpful assistance has been given to us on matters concerning packing of rubber, latex coagulants, and plasticity and colour of smoked sheet. At considerable trouble to itself and largely for our benefit, the Committee has agreed upon standard methods for the estimation of the deleterious metals copper and manganese in rubber. It is also making efforts to establish a greater measure of uniformity in rubber-testing methods and has already made considerable progress. Co-operation with this body will be actively continued in the coming year.

Mention has been made earlier of valuable co-operation with the Sumatran laboratories of the Goodyear Tire and Rubber Company Inc. of Akron U.S.A.

Lectures

The following lectures were given during the year:—

Lecturer	*Venue*	*Subject*
J. H. Piddlesden ...	Mentakab, Pahang	The Theory of Rubber Drying with notes on its application to Estate Practice
K. C. Roberts ...	I.S.P. Conference Kuala Lumpur	The Composition of Latex

Publications

(1) "The Constituents of Hevea Latex" Part I
"The Isolation and Quantitative Determination of the Constituents"
by K. C. Roberts

J.R.R.I.M. **7,** (1936), 46.

(2) "Latex Straining Materials"
by J. D. Hastings and K. C Sekar

J.R.R.I.M. **7,** (1936), 55.

(3) "A Survey of Latex Coagulants used by Malayan Smallholders"
by Edgar Rhodes

J.R.R.I.M. **7,** (1936), 68.

Malayan Agri.-Horticultural Association Show

This year the Divisional exhibit included models of the two types of "Subur" smoke-houses, built on the scale of two inches to one foot. These models will eventually form part of a permanent exhibit in the museum of the Institute.

Occasion was also taken to demonstrate the process of concentration of latex by evaporation. The apparatus designed in the laboratories of the London Advisory Committee was employed for this purpose and attracted much attention.

An exhibit of latex-straining materials was also made. This included colorimetric demonstration of the rapid attack of alkalis on brass gauze.

Dr. Rhodes, Mr. Moore and Mr. E. A. Barbour acted as judges in the All-Malayan Small-holders Rubber Competition and prize-winning and highly-commended exhibits were adequately displayed.

Two small-holders smoking cabinets were erected and demonstrated in operation. They attracted considerable attention from Asiatic visitors.

EDGAR RHODES

Senior Chemist

Kuala Lumpur,

28th January, 1937

ANNUAL REPORT

EXPERIMENT STATION

Acreage Statement

Planted	...	994.75 acres	{In bearing 431.25 ac / Immature 563.50 ac}
Building sites, roads, etc.	...	67.00 ,,	
Elephant belt	...	64.00 ,,	
Reserve area	...	225.45 ,,	
		1,351.20 ,,	

N.B. Not included in above totals are two seed gardens of 10 acres total, in the Forest Reserve, which are occupied under permit.
These areas are reserved for seed production of *Hevea spruceana* and the *H. brasiliensis* × *spruceana* cross for stock experiments.

Distribution of Land

Botanical Division	...	716.35 acres
Soils Division	...	221.40 ,,
Pathological Division	...	28.00 ,,
Chemical Division	...	29.00 ,,
Building sites, etc.	...	67.00 ,,
Elephant belt	...	64.00 ,,
Reserve	...	225.45 ,,
		1,351.20 ,,

The Pathological Division carries out routine pest and disease inspection over the whole Station, whenever this is necessary.

Clearing

No extension of land was carried out in the reserve area, but during the year the elephant belt adjoining the following blocks was strip-rentised and planted, no burning being done, except in Block 6A.

Block 6A

An area of 4 acres elephant belt felled, burnt, stumped, cleaned up and dug over, prepared for a collection nursery for special clonal seed. The work was done by our own Tamils.

Block 15A

An area of 6.75 acres of elephant belt along eastern boundary of Block 15 was felled, strip-rentised 6 ft. wide and planted.

Block 23A

An area of 8.25 acres along the western and southern boundaries of Block 23 was felled, strip-rentised 6 ft. wide and planted.

LINING, HOLING AND PLANTING

Block 6A. 4 acres

This nursery was laid out with beds 12 ft. × 113 ft. Planting material used for this nursery was clonal seed collected on the Station, which was germinated and then planted out in the beds.

Block 12

This old nursery area of 7 acres was lined, holed and planted as follows :—

Lining 22 ft. × 11 ft. Holing 2 ft. × 2 ft. × 2 ft. Planting material : illegitimate seedlings from high-yielding mother-trees, mainly crosses of known parentage, with the following budded stumps as controls, P.B. 186, AVROS. 157 and B. 84.

Block 13A. 2½ acres

This old cover-plant nursery was cleaned up, lined and planted as follows :—

Lining 15 ft. × 15 ft. Holing 2 ft. × 2 ft. × 2 ft. Planting material was estate seed, one seed in a basket and three seed at stake per hole.

The area was then divided up by isolation drains and a manurial experiment with controls was laid down.

Block 15A. 6.75 acres

Lining 20 ft. × 15 ft. Holing 2 ft. × 2 ft. × 2 ft. Planting material was clonal seed in baskets.

Block 23A. 8.25 acres

Lining western part 22 ft. × 15 ft. and southern part 18 ft. × 18 ft. Holing 2 ft. × 2 ft. × 2 ft. Planting material :

Western section 6¼ acres : families of clonal seed of a number of proved clones.

Southern section 2 acres : seedlings of clones A.44 × B.84 from duo-clone planting ; budded stumps of P.B.186 as control.

Nurseries

Block 1—Main Multiplication Nursery. 6 acres

300 beds of ordinary seedlings for budding.
120 beds of clonal seed.

Budding carried out in April—May and a complete collection of all proved clones used on the Station has been established.

A small stump nursery was planted up at the northern end of Block 1 to serve as a demonstration nursery, for budding operations, to Asiatic Rubber Instructors and visiting conductors.

Block 4B. 5 acres

Beds from which material for multiplication purposes had been removed, were eradicated.

A number of beds are still left, as material from them is required for despatch to estates co-operating with the Institute in experimental work. It is hoped to eradicate this nursery completely by the end of 1937.

Block 6A.

Growth in this nursery is good, and the northern portion has been reserved for investigations by the Botanical Division on stock selection (using clonal seedlings) and root development.

Manurial Treatments

Block 1

Applications of Sterameal were put down on beds where budding operations were completed.

The cover crop experiment along the western side of this block, (2 acres) was manured as follows :—

Gafsa rock phosphate at the rate of 1 cwt. per acre.
Cheribon „ „ „ „
Christmas Island „ „ „ „
Basic slag „ „ „ „
Each treatment was replicated 4 times.

Block 5A

Backward plants were manured with Supram, to try to establish a hundred per cent stand for budding later.

Block 6

This manurial trial block of 40 acres had its annual application of artificial fertilisers and farmyard manure laid down in April. Girth measurements and yields were taken and records were sent to the Soils Division.

Block 6A

Sterameal was broadcast over the beds.

Blocks 7 and 8

Cover Plant and Clean Weeding. 10 acres clean-cleared. 10 acres stumps left.

Natural die-back of the bushy covers, especially *Crotalaria anagyroides* was marked, and the areas under covers were manured early in 1936.

Basic slag at the rate of 1 cwt. per acre was broadcast.

Block 12 (7 acres)

During the planting of this plot, 8 oz. of Sterameal were put in the top-soil in each hole.

Cover plants of the bushy leguminous type were planted in 1935, and where bare patches were seen, cover-plant seed with ½ matchbox-full of Sterameal was applied.

Block 13A

This area of 2½ acres was divided by isolation drains into 16 plots and was replanted, using four different fertilisers with four replications, viz :—

(*a*) Sterameal
(*b*) Enpekay No. 2
(*c*) Complete fertiliser
(*d*) Humus-fertiliser and potash

} 1st application

Pueraria cuttings were planted between the rubber rows and Enpekay No. 5 cover crop mixture was broadcast to help the covers to establish.

Block 14 C and D. Density-of-Planting Experiment. 40 acres.
Clone A.V.R.O.S. 50

One plot in this area is very backward and distinct "yellowing" of the cover plant is noticeable.

This plot has been taken out of the main experiment and treated as follows :—

The plot was divided into four sections, by 2 ft. × 2 ft. isolation drains. Half the area was manured with Enpekay No. 2 at the rate of 2 lb. per tree. The other half was manured with a complete fertiliser consisting of equal parts of ammonium sulphate, Christmas Island rock phosphate and sulphate of potash at the rate of 2 lb. per tree.

Block 18

Had its annual application of 1 lb. of sterameal per tree, laid down in April.

Block 23. Soil Exhaustion Experiment

In this Block two areas, one of 26 acres, and one of 10 acres, were demarcated for manurial trials on seedling rubber that had been interplanted with catchcrops, (pineapples, coffee and tapioca) for five years.

Each area was divided into nine equal plots, separated by isolation drains.

The following manures were applied with three replications :

A. Control
B. Enpekay No. 1
C. Sterameal Young Rubber Mixture.

Before the manures were applied, girth measurements were taken on the rubber at 36 inches, and manures were applied to the trees at the following rates :—

15 in.—18 in.	15 in.—10 in.	10 in. & under	Manure
2 lb. per tree	1 lb. per tree	½ lb. per tree	NPK.1
2½ „ „	1¼ „ „	½ „ „	Y.R.M.

18 in. and over—not manured.

Block 24. Soil Erosion Experiment

This experiment on one of the steepest areas, is based on the use of covers running in 1-chain-wide strips down the hill.

Measuring posts are placed on and between terraces to record soil movement. Each strip is segregated from the next by a strip of Citronella grass. The following covers were originally planted :—

a. *Calapogonium mucunoides*
b. *Pueraria javanica*
c. *Indigofera endycaphylla* (now replaced by *Clitoria cajanifolia*)
d. *Crotalaria anagyroides*
e. *Vigna hosei*
f. *Centrosema pubescens*
g. *Tephrosia candida*
h. Grasses
i. Clean weeding

Owing to the density of shade experienced during the last two years, severe die-back of the covers is noticeable. The following manures were applied :—

1. Control plots—no manure
2. Gafsa rock phosphate
3. Basic slag
4. Cheribon rock phosphate
5. Christmas Island rock phosphate

Block 30. Rubber in Indigenous Covers with no burning of timber etc. 40 acres.

Sterameal at the rate of ¼ lb. per plant was laid down, where it was seen that few plants were definitely retarded, and below the standard growth of the rest of the area.

This area is required for testing of new clones derived from high-yielding legitimate seedlings.

Block 31. Rubber in Indigenous Cover with light burn. 40 acres.

The area is laid out as a Latin Square with six treatments replicated six times.

Treatments used are :—

1. Control—no manure.
2. Nitrogen only
3. Nitrogen and potash
4. Nitrogen and phosphate
5. Potash and phosphate
6. Enpekay No. 1

Owing to planting late in the year, it was possible to get only " end of the season " seed and growth was poor.

Supplying with basket plants three per point has been carried out this year.

SOIL-EXHAUSTION EXPERIMENT—BLOCK 23. 65 ACRES

The final eradication of the remaining catch crops was completed early in 1936. 36 acres of this block have been used as a manurial trial, described above in the paragraph on " Manurial Treatments."

The growth of the rubber in plots that were under tapioca and pineapples is very retarded.

In areas where leguminous creeping covers had not come away, Pueraria seed was planted. The whole area has had Christmas Island rock phosphate broadcast to help establish the covers.

THINNING OUT ETC.

From test-tapping results obtained in Block 17A (10 acres) planting 22 ft. × 11 ft., it was possible to thin out a number of poor trees. (Rubber aged 6 years).

Where no disease had been recorded over the whole period of six years, trees were cut off just below ground level and the roots were not extracted. In areas where disease had been recorded complete extraction was done.

Block 17D. (10 acres) Planting distance 11 ft. × 11 ft. Clonal seedlings age 4 years

A total of 1,057 trees were thinned out, and the same method of eradication as that followed in Block 17A was employed here.

Block 24. 22 ft. × 11 ft. (Contour planting)

In this monoclone block of B.D.5, 30 trees per acre were thinned out, leaving an approximate stand of 130 trees per acre.

Storm Damage

Severe storms occurred on the 30th June and 15th July; 1,076 trees were damaged.

Roads, Bridges and Drains

Normal upkeep of the main drainage system was carried out twice during the year. The anti-malarial system was cleaned monthly.

To facilitate the disposal of water, which during the rainy season collects in the terrace pits, on the western boundaries of Blocks 30 and 31, fifty chains of tap drains were cut into the adjoining jungle.

Roads were weeded monthly and repairs were carried out when necessary. Inspection paths round the boundaries and through fields with low creeping covers were upkept monthly.

Terracing, Silt Pitting and Budding

No new work was done under this heading during the year. Slight upkeep of terraces was necessary on the steep slopes in Block 24, where breakages occurred, owing to the die-back of covers.

Cover Plants

Blocks 7 and 8 (Covers vs. Clean Weeding)

The areas under cover plants, *i.e.* the bushy leguminous type, were slashed according to schedule. *Crotalaria anagyroides* in this block has now nearly all died back owing to the density of the rubber shade.

Lamtoro still continues to grow.

The area has been manured with basic slag and it is hoped that some of the covers will regenerate.

Block 13B

In this area *Melastoma polyanthum* (Straits Rhododendron) although kept strip-rentised along rubber rows, was seen

to become too predominant; the area was therefore cleaned up and is now weeded monthly.

Block 19. Monoclone area of B.D.5 (59 acres)

In the less hilly portions of the block, *Pueraria javanica* and *Centrosema pubescens* are growing luxuriantly.

To arrest competition owing to their dense growth, 6-ft. rings round the trees were kept free of covers.

A preliminary experiment on spraying covers with a weed-killer was carried out in a small area. Various strengths of sulphuric acid and sodium arsenite were tried.

It was found that the best and cheapest method was a 1 per cent. solution of sodium arsenite in water. It is proposed to continue this experiment over the whole area of Block 19, strip-spraying along rows of rubber on contour, during the dry weather in 1937.

Block 24

Five acres on the top of the hill in this block had been left as a demonstration plot for indigenous plants that are considered undesirable, e.g. Stagmoss, *Gleichena linearis, Pteris ensiformis,* and the true bracken.

Alternate terraces were cleaned up, and the balance will be removed as new growths of the good type of plants now established come up and arrest soil movement.

Owing to the heavy die-back of the low leguminous covers in this area, as a result of shade, cuttings of natural covers have been planted over the area so affected.

Cyrtandromoea acuminata, Cassia nodosa, Ficus fistulosa appear to be coming away well.

Block 26. Rubber in Natural covers. 6 ft. terraces kept clean weeded. 10 acres

The natural covers in this block were slashed down as low as possible, and it was observed that most of the natural growths have been superseded by a heavy growth of *Nephrolepis biserata* (fern) and *Hornstedtia* (wild ginger).

Growth of the rubber, however, does not appear to have been seriously retarded by these species, although the growth of wild ginger is very heavy in certain areas. One experimental area has been treated as follows:—

(*a*) wild ginger has been hand-pulled

(*b*) wild ginger has been cut as close as possible to ground level.

It is hoped that these methods will weaken *Hornstedtia* and will encourage a more varied stand of natural covers.

Costs of each of these operations have been kept for record.

Block 27. (*Annual Report 1935. R.R.I. Experiment Station*)

Some interesting points have been noticed during the year in this experiment :—

(a) *Leguminous Shrub Covers.* Lamtoro took too long to establish, and has been shaded out by the *Tephrosia candida* and *Crotalaria anagyroides.*

Six-monthly slashing to 3 ft. shows that the *Tephrosia candida* stands up to slashing best.

In several bare patches serious erosion occurred and those patches have been planted with *Clitoria cajanifolia* and *Desmodium ovalifolium,* both of which are growing well, and have checked erosion very satisfactorily.

(b) *Leguminous Creeping Covers. Pueraria javanica* has become dominant but Centrosema is still present in fair quantity. Weeding costs are slightly enhanced owing to the rapidity of growth of Pueraria on to the clean-weeded terraces.

(c) *Natural covers with minimum control.* Only plants that tend to overshade the rubber are lightly topped, and eradication of all grasses was carried out; resultant bare patches have been supplied with cuttings of Timonious, *Cassia nodosa,* etc.

(d) *Natural covers. Bushes and Nephrolepis ferns only, slashed to 3 ft. every six months.*

As recorded in other natural cover experiments on this Station, where regular drastic slashing is done the natural covers tend to die back and a heavy growth of *Nephrolepis biserata* takes charge.

(e) *Natural covers. Bushes only, no ferns, slashed to 3 ft. every six months*

The regular eradication of Nephrolepis and other fern species has improved the composition of the ground flora at present standing on these areas.

N.B. In all "forestry" blocks except Block 11 (uncontrolled area), Lantana is eradicated on sight.

Mr. Kaimal has made regular collections of the various species of natural covers on this clearing. Over 100 species of plants have been recorded and their growth under different conditions and methods of treatment is being studied.

Blocks 28 and 29. 12.8 acres

Natural covers in these blocks, between the clean-weeded terraces, are slashed to a height of 4½ ft.—5 ft. once a year.

Here little or no die-back of covers is to be seen and the growth of the rubber is excellent.

Blocks 30 and 31. Rubber in forestry (Block 30, no burning, 40 acres) (Block 31, slight burn, 40 acres)

Natural covers slashed to 5 ft. every six months. Excellent regeneration of natural covers is to be seen over the whole area.

Part of this clearing near the forest boundary of Block 31 has been attacked by the caterpillar Achea.

Spraying with a lead arsenate solution, has helped to check this trouble.

RUBBER UNDER "FORESTRY CONDITIONS." 10 ACRES
(Annual Report. Expt. Station, 1935)

Growth of the rubber in the cleaned-up strip in both planting distances is excellent, whilst considerable retardation of the rubber is to be seen in the uncontrolled, unslashed areas.

In the natural cover areas, slashed, both wide and close planting, it was noticed that the natural growths were disappearing and a strong stand of *Nephrolepis biserata* (fern) was predominant.

Slashing to 3 ft. every six months, as had been carried out in the past, was modified to slashing six-monthly of the *Nephrolepis biserata* only.

By the end of the year, it was seen that a number of the natural growths were regenerating and holding their own against the *Nephrolepis biserata*.

Termite attacks, both in the slashed and unslashed areas, are worse in this block than in any other on the Station.

It is interesting to note that in this block, during the eight years the experiment has been in progress, only eighteen trees have been affected by root disease.

Yields from this block are interesting.

The average yields per acre for 1936 were :—

Cleaned up	22 ft. × 11 ft. ...	593 lb.
,,	22 ft. × 22 ft. ...	330 ,,
Slashed	22 ft. × 11 ft. ...	525 ,,
,,	22 ft. × 22 ft. ...	316 ,,
Unslashed	22 ft. × 11 ft. ...	415 ,,
,,	22 ft. × 22 ft. ...	279 ,,

Yields for December from the various treatments are as follows :—

Planting distance 22 ft. × 11 ft. (5 acres)

(*a*) Unslashed uncontrolled area ... 708 lb. per acre.
(*b*) Slashed and selectively weeded ... 816 „ „ „
(*c*) Cleaned up, clean weeded area ... 864 „ „ „

Planting distance 22 ft. × 22 ft. (5 acres)

(*a*) As above ... ... 432 lb. per acre.
(*b*) do. ... ... 456 „ „ „
(*c*) do. ... ... 516 „ „ „

Little mouldy rot has been noticed this year and what was seen was treated by the tappers with 10 per cent. solution of Brunolinum.

Soil-Erosion Experiment Block 24

For details see above in the paragraph on "Manurial Treatments."

Seed of *Desmodium ovalifolium* planted under shade have germinated satisfactorily and the cover is spreading well between the terraces.

Cultivation

Alternate-monthly weeding and forking of 8 ft. rings round young plants is carried on in all fields of young rubber, up to three years of age.

Block 19. Digging in of covers and grasses six-monthly (6 acres)

This work was done twice during the year according to schedule.

Measurements of girth were recorded and sent to the Soils Division.

Block 25 (8 acres—Cover Plant and Clean-weeding experiment)

Lamtoro still continues to stand up to the regular slashings and the girth of the rubber in these cover plots is ahead of the others.

Measurements were taken at required intervals.

Diseases and Pests

Root Diseases

Regular rounds of inspection and treatment for cases of all three of the main root diseases were carried out during the year.

Treatment was the same as that described in the Annual Report for 1934. Details are given in the table at the end of this section.

Mouldy Rot

This disease was recorded only in the "Forestry" Block 11. It soon yielded to treatment with 10 per cent. Brunolinum.

Canker of Unknown Origin

No further cases of this disease occurred and the affected trees are healing over well after treatment.

Pink Disease (Corticium salmonicolor)

Sporadic attacks were recorded during the year, but all yielded to treatment with asphaltum and kerosine mixture and 20 per cent. Brunolinum.

Oidium Heveae, Red Spider, Mites, Thrips

No traces of *Oidium Heveae* were seen over the Station during the year, but a considerable amount of defoliation was caused by red spiders, mites, and *Thrips* in April.

Clone A.V.R.O.S. 50 in the first clone trial experiment (Block 5) was again seriously attacked, owing probably to its tendency to winter late.

In all, 400 acres of the most severely affected areas were dusted with sulphur, and good refoliation resulted, after the five-weekly rounds were completed. The new Vermorel duster was used and proved most satisfactory.

Cockchafer Grub. Psilopholis grandis

Several of these grubs were found to be eating the young plants in Block 6A Nursery, but so far the attack has not been of a serious nature and no special treatment has been done.

Termites (White Ants)

The standard treatment on the Experiment Station for trees attacked by termites is "Cymag" followed by sodium silico-fluoride. The bole of the affected tree is scraped and ¼ to ½ ounce of "Cymag" dusted on the earth thus collected, followed by a dusting next day with a similar quantity of sodium silico-fluoride.

Other treatments, used experimentally, are mercuric chloride, paradichlorbenzene, Paris Green, and a jelly made from rubber and carbon disulphide.

Caterpillars (Achea sp.) (Annual Report Expt. Station, 1935)

As noted elsewhere an attack by these pests occurred near the jungle in Block 31. Spraying with a 1 per cent solution of

lead arsenate reduced the severity of the attack. It was noticed that again *Trima (angustifolia* and *amboenensis)* were the first plants to be attacked.

Giant Snail

Considerable damage to young plants in Block 1 Nursery occurred from attacks by these pests.

It was found cheapest in the end to put on non-working children on "cash" payment, to collect these pests regularly.

Rat damage

In Block 30 a number of seed at stake were eaten by rats, and various chemical baits etc., were tried, without success.

It was found that where the seed was dipped in a weak solution of lead arsenate,the rats turned the seeds over, but did not eat them, and consequently plants with crooked roots and stems resulted.

Lightning Attack

Ten trees were damaged by lightning during the year.

Details of trees affected and trees eradicated and treated are as follows:—

Disease	Trees treated	Trees removed	Total
Fomes lignosus ...	1,118	320	1,438
Ganoderma pseudoferreum ...	81	59	140
Fomes noxius ...	29	5	34
Ustulina ...	12	5	17
White Ants ...	3,242	247	3,489
Lightning ...	—	10	10
Pink disease ...	855	—	855
	5,337	646	5,983

JUNGLE PLOTS A AND B (10 ACRES)

Routine weeding is carried out monthly, the area now being clean-weeded to facilitate the collection of seed of *Hevea spruceana* and the cross with *H. brasiliensis.*

A few seed set in the pure *Hevea spruceana* plot last year. These were collected and 35 germinated.

There are signs that a larger amount of seed will be available in 1937.

No trace of *Oidium Heveae* or other leaf disease was noted on either of these plots during the year.

Termites are still troublesome, but monthly rounds of inspection help to check the ravages of these pests.

Weeding

The system of alternate-monthly weeding and forking continues in all fields up to three years of age.

In older fields the covers are not being kept back to 8 ft. but are allowed to grow right up to the trees. This practice is not generally recommended on estates.

Selective weeding and slashing costs in natural cover blocks are kept for each plot so treated and are proving of interest to visitors.

Lalang

Lalang patrols keep the new clearing "Forestry" areas, Blocks 28, 29, 30 and 31 clear of sporadic lalang.

Over the rest of the Station practically no lalang is to be seen.

Slashing

The building site is slashed monthly, the work entailing slashing 36 acres of compounds, lines and factory site.

Slashing of the drain edges has had to be reduced to one slashing every five or six months, as it was found that regular monthly slashings were killing off the grasses.

Budgrafting

Normal upkeep pruning rounds etc., have been carried out on the newly-budded areas.

Demonstrations by the Station budding coolies have been given at various agricultural shows.

The method of budding badly-grown five to six-year-old rubber, has also been demonstrated at these shows.

Identification of clones, in the field and in the nursery, on several estates, was carried out, when requests for such work were received. Budding operations were carried out in the following blocks :—

Block 1 Nursery. Budded with material from numerous clones, for clone collection and museum.

Block 27. 10 acres. Material: B.D.5, Pilmoor D.65, and B.84, Prang Besar 86, and Tjirandji 1.

Blocks 28 and 29. (12·7 acres) Material: Prang Besar 23, Glenshiel 1, Tjirandji 1, Pilmoor D.65 and B.84. Stocks for this experiment are seedlings grown from identified clonal seed.

Some budwood has been supplied to estates co-operating with the Institute in schemes of experimental planting. The sale of

budwood is now restricted to the supply of material for experimental and demonstration work.

TAPPING EXPERIMENTS. (ANNUAL REPORT EXPT. STATION 1935)

Block 5 Boundary Rows.

Tapping of the trees in the plot boundary rows in this block has been continued.

Tapping is alternate-daily, and individual tree yields are recorded by the method of cup coagulation and weighing of the resulting samples.

Preliminary tests of "double-cut" tapping of buddings are in progress.

Block 6 Boundary Rows.

The tapping experiment mentioned in the Annual Report 1935, was continued. Recording is by cup samples, alternate-daily.

A comparison between "double-cut" systems, full-spiral tapping and normal tapping on half-circumference is being made. In this experiment, in order to obtain the comparative data required, it is necessary to increase bark consumption for some of the tests.

Block 14 C and D. Density-of-Planting Experiment. 40 acres.

In this block 20 acres are clean-cleared of all surface timber and stumps, and 20 acres have the stumps and timber left on the ground.

There are 36 plots laid out in a Latin square, (each treatment replicated 6 times).

Density varies from 48 trees per acre to 435 trees per acre. The boundary rows are tapped separately from the inner trees in the plots, and the latex from these trees is bulked. The centre trees in each plot have the yields recorded separately.

Block 17D North. 10 acres.

Test-tapping on a half-spiral at 20 ins. was carried out for ten days in this block of clonal seedlings, in preparation for thinning. As the proportion of trees which had reached the minimum girth required for test was small, thinning-out was done first on girth and general appearance, and then later on yield results.

Details of Fields in Tapping

Block	*Acreage*	*Planting Distance*	*Material*	*System of Tapping*	*Method of Latex collection*
2	30.0 acres	30′ x 30′	Seedlings from the oldest-known trees, clonal seedlings from isolated seed gardens in Java and seedlings of Pilmoor clones.	Left half spiral A/D at 22″	Cup coagulation. 1/1/1936.
3	9.25 „	20′ x 20′	Buddings from hand-pollinated crosses in Block 4	Left half spiral A/D at 40″	Cup coagulation. 1/1/1936.
4	10.0 „	20′ x 20′	Seedlings hand-pollinated crosses and controls from Pilmoor Estate	Left half spiral A/D at 22″	Cup coagulation. 1/1/1936.
5	40.0 „	20′ x 20′	Monoclone Latin Square of 9 clones. A 44, B 84, B.D. 5, Tj. 1, A.V.R.O.S. 49, 50, 152, P.B. 23 and 186	Left half spiral A/D at 40″	Latex from each plot is collected separately. 1/1/1936.
6	40.0 „	22′ x 22′	Seedlings. Manurial trial Block. Six treatments replicated six times	½ Left spiral; or ½ V cut. A/D at 22″	Latex from each plot kept separate. 1/1/1936.
7	10.0 „	22′ x 22′	Seedlings. Clean-weeding vs. Covers	Left half spiral A/D at 22″	Latex from each treatment kept separate. 1/1/1936.
8	10.0 „	22′ x 22′	Seedlings and 290 buddings made from high-yielding brown bast trees	Both left half spiral. Seedlings A/D 22″ Buddings A/D 40″	Latex kept separate. Cup coagulation. 1/1/1936.
9	8.0 „	22′ x 22′	Seedlings ½ clean, ½ stumps and timber	Left half spiral A/D at 22″	Separate buckets for each treatment. 1/1/1936.

Details of Fields in Tapping—(*Contd.*)

Block	*Acreage*	*Planting Distance*	*Material*	*System of Tapping*	*Method of Latex collection*
11	10.0 acres	½ 22′ x 22′ / ½ 22′ x 11′	Seedlings in "Forestry" conditions	Left half spiral A/D at 22″	Latex from each treatment kept separate. 1/1/1936.
13B	2.5 „	22′ x 22′	Seedlings	Bark removal expt. Half spiral and V cuts. A/D 22″	Cup coagulation. 1/1/1936.
14 A & B	40.0 „	20′ x 20′	Buddings new clones from 1929 hand-pollinated crosses. Block 16	Left spiral A/D at 40″	Cup coagulation. 1/1/1936.
14 C & D	40.0 „		Buddings of clone A.V.R.O.S. 50. Density-of-Planting Experiment	Left spiral A/D at 40″	Latex from each plot collected separately. 1/7/1936.
14 E_2	9.0 „	20′ x 20′	Seedlings (crosses) and buddings as controls	Left spiral A/D at 22″ and 40″	Cup coagulation. 1/7/1936.
14 F	1.0 „	22′ x 22′	Seedlings	Left spiral A/D at 22″	Latex collected and kept separate for Chemical Div. work. 1/1/1936.
16	40.0 „	20′ x 20′	Seedlings and Buddings 1930 hand pollinated crosses of Pilmoor clones. Buddings as controls	Left half spiral A/D at 22″ and 40″	Cup coagulation. 1/1/1936.
17 A	10.0 „	22′ x 11′	Seedlings and Buddings in mixed planting Gl. 1, Tj. 1 and 16, A.V.R.O.S. 50, 183 and 185	Left half spiral A/D at 22″ and 40″	Cup coagulation. 1/1/1936.

Details of Fields in Tapping—*(Contd.)*

Block	*Acreage*	*Planting Distance*	*Material*	*System of Tapping*	*Method of Latex collection*
21	25.0 acres	20′ x 20′	Polyclone buddings. Clones A.V. R.O.S. 50, 71, 256. B.D. 10, Ct. 88, Tjr. 16 and S.R. 9	Left half spiral A/D at 40″	Cup coagulation. 1/1/1936.
23	29.0 „	20′ x 20′	Kepong Estate seedlings.	(*a*) Sunderland 2 cuts at 20″ and 40″ 3rd daily. (*b*) Half spiral A/D at 20″ (*c*) Half spiral daily at 20″ 1 month's tapping and 1 month's rest.	Latex in each treatment kept separate. 15/10/1936.
24	33.0 „	22′ x 11′	Monoclone B.D. 5 buddings.	Left half spiral A/D at 40″	Latex bulked at store. 1/7/1936.
25	12.0 „	18′ x 18′	Crosses buddings and clonal seedlings.	Left half spiral A/D at 20″	Cup coagulation. 1/1/1936.

The total area tapped A/D monthly during the year was ... ... { 314·25 acres for 12 months / 117·00 „ 6 „ } or a total of 431·25 acres.
and a crop of 90,355 lbs. was obtained.

Tapping

During the year the following blocks were in tapping. The system of tapping for all blocks was A/D, buddings being opened at 40 ins. on a left-hand spiral cut on half circumference.

Seedlings are opened at 20 ins. on a left-hand spiral on half circumference.

In the manurial trial, Block 6, each plot of 80 trees is divided; one half is tapped on a left spiral at 22 ins. and the other half on a V-cut at 22 ins., using A/D in each case.

If estimates of yield are computed by readers of this report, it should be remembered that in a number of areas out of the 431·25 acres mentioned above, only parts of the stated acreage are in actual tapping.

Owing to budding operations being done at different times, when material became available, only parts of the blocks are in tapping.

During the year tapping was suspended for 27 days, owing to rain and holidays, and on 94 days rain interfered with the tapping.

The hand-pollinated crosses mentioned in the above details, were made on Pilmoor Estate, Selangor, by officers of the Institute and were then established on various blocks on this Station.

Block 6 Manurial Trial was tapped by Chinese coolies in 1935, and during 1936 Tamil tappers were employed.

In all blocks tapping tasks are rotated monthly to help eliminate the human factor.

Bark consumption varies between $\frac{1}{2}$ in. to $\frac{3}{4}$ in. per month on the A/D system of tapping. In special plots such as Block 14 C and D (Density Expt.) plot fencing has been done to save any errors from tappers crossing over to the next plot.

Tappers tapping areas of monoclone or polyclone buddings carry two Andrew's gouges, one $\frac{3}{8}$ in. and one $\frac{5}{16}$ in., to facilitate the tapping of buddings with varying bark thickness. Gouges are dipped, twice a week, in a strong Lysol solution, to guard against mouldy rot.

Bark shavings are kept in wire baskets on the trees, and are collected twice a month, creped and weighed.

Curing

The factory is fully equipped to deal with latex in bulk, when necessary.

Owing to the need for the rubber from each plot to be kept separate, at present, only pan sheet is made.

Sheet of $\frac{1}{8}$ in. thickness is turned out, on the F.E.Co. Major battery, and this sheet when smoked in the large "Kampong Type" smoke-house, dries in five days.

Sheet made from latex from Block 5 (clone trial) is smoked in the small Devon smoke-house and dries in three days.

Formic acid only is used in the factory, and samples of rubber from various clones etc., are taken daily for recording purposes.

Sheet made from buddings shows considerable variation in colour between the different clones.

A good quality compo is turned out on our creping battery.

Semi-dried cup samples are creped on this battery, dried, and weighed, for record purposes.

Samples of smoked sheet from virgin seedling rubber and buddings, are reserved for Mr. Hastings, of the Chemical Division.

Drying Shed

The special drying shed for Botanical Division samples has had to have more racks put in, as there are now over 80,000 samples a month to be weighed and recorded.

Rubber is despatched by lorry for sale to dealers in Kuala Lumpur, and no packing is done.

Measurements

Girth measurements were taken at regular intervals over the following blocks :—

2, 3, 4, 5, 6, 7, 8, 9, 11, 14, 15, 16, 17, 20, 21, 22, and 25.

Measurements of height and spread of clonal seedlings in Block 27 were also recorded.

Special Works

Thirty-feet scaffoldings, for the purpose of hand-pollination between various clones, were erected in Block 4.

Further scaffoldings will be put up in Blocks 4, 5, 15, 17A and 20 in 1937.

Medical and Health

The health of the staff, both European and Asiatic, has been excellent during the year.

A slight influenza epidemic occurred during December and a number of the labourers were affected.

During the wet season, labourers are issued with "kunji" (hot rice water) at morning muster. The cost of this issue is defrayed by toddy shop profits.

The special method of brush-oiling employed on this Station has worked satisfactorily.

Drs. Cameron and Mackintosh continued to act as our V.M.Os and my thanks are due to them for their advice.

A number of medical officers from the League of Nations anti-malarial course held in Singapore, visited the Station with the Health Officer, and our methods of oiling were demonstrated.

Rainfall

The rainfall for the year was 93.69 inches.

Buildings and Machinery

All buildings and machinery are in a good state of repair, and all are fully covered by insurance.

New Buildings

A new bucket store was put up during the year. A portion of this store has been made into an office for the use of officers of the Chemical Division, when they carry out experiments on the Station.

Work on a new set of concrete and plank coolie lines, 10 rooms, was begun in December.

These lines have two verandahs, one at the front and one at the back. The back verandahs are wired in, and can be used as cooking places, and pots and pans can be left out in them, while the coolies are at work.

The cost of the completed lines will be $190/- per room.

New Smoke-House

During the year, the Asiatic (Indian) Rubber Instructor, Selangor, erected a new type of "Kampong" smoke-house.

This building is made with walls of split bamboo lined with paper from cement bags. The roof is made of attaps.

There are two chambers 12 ft. × 12 ft. × 12 ft. under the one roof, and firing for each is done in an old half oil drum.

The capacity of each chamber is 1,800 lb. of rubber, and the cost of the whole building was $70/-.

Sheet of $\frac{1}{8}$" thickness can be dried in five days in this smoke house.

New Bungalow

A new bungalow for one of the married Asiatic staff attached to the Botanical Division, was erected.

Machinery

A new F. E. Co. Major battery with 6 rollers was installed and is working satisfactorily.

The creping battery consists of a 17 H.P. Crossley Engine and 3 sets of rollers.

This machine is functioning satisfactorily and has to put up with considerable wear and tear, as the semi-dry cup samples are hard and need a lot of milling before they are creped.

A bulking tank designed by Mr. Piddlesden, of the Chemical Division, has been installed.

The factory and its equipment are proving of considerable interest to visitors.

Water Supply

This system continues to give satisfactory results.

CORRESPONDENCE

Considerable correspondence was dealt with during the year. Planters and others are asked to note that correspondence requiring technical replies, should be addressed to the Director, R.R.I., who will pass it on to the Divisions concerned.

HISTORY FILE AND COST CARDS

An abridged guide to the Station is in course of preparation, and should be of considerable service to visitors.

The History File and Cost Cards are kept up to date, and are proving of great assistance to planters.

STAFF

The European Staff on the Station during the year was as follows :—

Manager	...	Mr. Foston
Asst. Manager	...	Mr. Dickson
Temp. Asst.	...	Mr. Stonehewer

The Manager proceeded to England on long leave, on March 19th and returned on November 21st.

During his absence on leave Mr. R. D. Stonehewer was temporarily engaged to assist Mr. Dickson.

The Asiatic Staff was as follows :—

1 Clerk
1 Dresser
2 Field Conductors
1 Tapping Conductor
1 Factory Conductor
4 Botanical Division Laboratory Assistants
1 Chemical " " " } Institute Staff
1 Pathological " " "

General

During the year under review 555 people visited the Station. Visits were paid by the following branches of the Incorporated Society of Planters, and D.P.As.

Central Perak (D.P.A.), Kajang, North Johore, Nilai-Labu, Kuala Lumpur, and Bahau.

The following members of the Board of the R.R.I. visited during the year;

The Chairman, Messrs. Cranna and Choo Kia Peng.

Visits were also received from members of Research Stations in Ceylon and the D.E.I., when opportunities were taken to discuss subjects of mutual interest.

A record number of visits were made by Chinese, Indian and Japanese planters and proprietors.

Directors of rubber companies from England, France, Belgium, Holland and Saigon visited the Station, on the way to see their own properties.

Regular courses of instruction were given during the year in budgrafting, pest and disease, and factory practice. Five Europeans and over 40 conductors and kanganies took advantage of these courses. This work has been temporarily suspended due to lack of accommodation, but will be resumed early in 1937.

On the request of the labour force, negotiations were opened with the Controller of Labour, for a toddy shop on the Station. Permission was obtained and the toddy shop was opened in October.

The opening of the toddy shop has not interfered with labourers subscriptions to their Co-operative Society Fund.

The building erected as a field laboratory for Divisions has been taken over for use as the Station office.

Owing to the large increase in the children on the Station, it became necessary to have a larger school; our old fertiliser store was cleaned up and has been seen and approved for use as a school by the officers of the Education Department.

Owing to potash-deficiency, and perhaps also to the "iron-pan" known to exist on certain areas of the Station, distinct yellowing of the foliage became noticeable during the year. The Director has approved a manurial programme for these areas for 1937.

Recording of tapping yields increases yearly, and this year there were over 80,000 samples to weigh each month.

Clonal seed was collected during the year, whenever it became available, for our own use and for distribution to estates co-operating with the Institute.

Thanks are due to the General Manager, Kepong (Malaya) Rubber Co., the Manager of Bujong Estate, and the Manager of Pilmoor Estate, for their assistance in manufacturing our rubber until our factory was ready.

The work of the staff, both European and Asiatic, is noted with appreciation.

A considerable amount of overtime work was necessary during the year, to cope with the large programme, and all the staff gave me valuable assistance.

The labour force worked well and was contented, no trouble or unrest occurring during the year.

In conclusion my thanks are due to the Director and Research Officers co-operating with me on the Station.

H. W. Foston

Manager

Sungei Buloh,

29th January, 1937

ANNUAL REPORT

LONDON ADVISORY COMMITTEE FOR RUBBER RESEARCH (CEYLON AND MALAYA)

The Committee and Technical Sub-Committee held three meetings during the year.

Dr. H. A. Tempany, C.B.E., was co-opted on the Committee on retirement from Malaya.

The following members of the Boards and staffs of the Rubber Research Institute, Malaya, and the Rubber Research Scheme, Ceylon, attended meetings of the Technical Sub-Committee and Committee during the year:—Mr. O. T. Faulkner, Colonel B. J. Eaton, Messrs. H. J. Page, T. E. H. O'Brien, H. S. Blacklin.

Several conferences were held by the technical staff with the Directors of the Rubber Research Scheme, Ceylon and the Rubber Research Institute, Malaya on the investigations in progress at the Imperial Institute and in the East, and arrangements made for them to establish personal contact with representatives of manufacturing interests in this country.

Visits to the laboratories were also paid by Messrs. Beeley and Moore of the staff of the Rubber Research Institute.

At the request of the International Rubber Regulation Committee the activities of the Committee and the work in progress in the laboratories were discussed with M. Leon Enderlin in connection with an enquiry he was conducting as to the research which could most usefully be undertaken by the French Institution for Rubber Research.

Finance

The expenditure incurred in connection with the work of the Committee during the year amounted to £3,230.12.11. After allowing for reserve for plant and for liabilities outstanding, there was an unexpended balance of £800 at 31st December, 1936.

During the year it was suggested to the Committee that the funds to be provided for research with a view to developing "new applications" of rubber under Article 19 of the Final Agreement embodying the terms and provisions of the International Rubber Regulation Scheme would not be available for the work carried out by the Committee as a complement to that of the Rubber Research Schemes in the East and that the financing of the London section of the work would have to be undertaken by these organisations and not by the

International Rubber Research Board as had previously been assumed. This view was confirmed on enquiry of the International Rubber Regulation Committee and it was proposed to the Boards in the East that, in order that a satisfactory scheme of work may be planned and reasonable security given to the staff, financial provision at the rate of £3,500 per annum should now be made for the continuation of the work in London for a period of five years.

In view of the great difference in rubber acreage in Ceylon and Malaya, the Committee expressed the opinion that the existing basis of equal contributions by the two countries is inequitable and, after consideration of all the circumstances, the following ratio was suggested—Ceylon 25% Malaya 75%. Approval to this proposal has been given by the Ceylon Rubber Research Scheme, but at the time of the preparation of this Report the official notification of the decision of the Board of the Rubber Research Institute, Malaya had not been received, but it is understood that they have agreed to make the increased payment suggested for the year 1937.

Appointment of Staff in Malaya

In accordance with the authority received from the Government of the Federated Malay States in 1935, steps were taken to fill the vacancy for a Director of the Rubber Research Institute caused by the retirement of Lt. Col. B. J. Eaton, O.B.E. Twenty-one applications were received in answer to the advertisement issued. These were carefully considered by a sub-committee to one or more members of which all the candidates from overseas were known personally. The sub-committee were unanimously of opinion that the qualifications of Mr. H. J. Page, M.B.E., B.SC., F.I.C., Controller of Agricultural Research at the Agricultural Research Station maintained by Imperial Chemical Industries, Ltd., at Jealott's Hill were so outstanding that they were not justified in submitting any other name as an alternative for the consideration of the High Commissioner for the Malay States. The recommendation of the Committee was approved by the High Commissioner and Mr. Page proceeded to Malaya in July.

At the request of the Board of the Rubber Research Institute, an advertisement was issued towards the close of the year inviting applications for the following vacancies on the staff of the Institute :—

(1) Botanist;
(2) Advisory Officer, Botanical Division;
(3) Advisory Officer, Soils and Chemistry Division; and
(4) Junior Assistant, Experiment Station.

Investigations

A detailed description of the technical work is given in the appendix and reference can most usefully be made here to those in-

vestigations which are developing beyond the laboratory stage and to the principal new lines of work undertaken during the year. A list of the reports furnished to Ceylon and Malaya is given at the end of this Report.

For many industrial uses uniform high-grade latex is required and it is necessary, therefore, that a satisfactory testing method should be available. As a result of considerable experimentation simple and suitable coloured standards for general use by the trade have been devised and submitted to the Rubber Trade Association who are giving them favourable consideration. In view of the fundamental importance of stability (rate of decrease in resistance to coagulation) considerable attention is being given by rubber technologists to formulating a satisfactory test but general agreement has not been reached as to the best procedure. The method now under consideration by the Committee promises to be satisfactory.

Among a number of other latex investigations carried out during the year the study of the lowest temperature which different types of preserved latex will withstand without coagulation and the development of the apparatus devised in the laboratories for the concentration of latex by evaporation are of special interest.

Two products which may be of industrial value (1) as a moulding powder, and (2) for the manufacture of superior ebonite were obtained during a study of the chlorination and bromination of a sample of acid latex and the Rubber Growers' Association and the Research Association of British Rubber Manufacturers were asked to arrange for technical trials to be carried out on these materials.

One of the materials prepared in the experiments which have been proceeding at the Rubber Research Institute with the object of obtaining a special type of rubber having a low water-absorption to meet the requirements of the electrical industry has attracted considerable attention by manufacturers in this country, and several requests for samples and enquiries as to the conditions under which commercial supplies could be obtained have been received.

Work was continued in close association with the Limmer and Trinidad Lake Asphalt Company on the use of an asphalt-rubber mixture as a binding material for highway surfacing, for which a grant has been received during recent years from the R.G.A. Technical Research Committee. The section of roadway laid by the Company in 1935 and referred to in the Committee's report for that year continued to show satisfactory non-skid properties, presumably due to the effect of rubber on the flow of the bitumen, and arrangements have been made for a more extensive trial on the public highway early in 1937. In this trial tests will be made not only with the mixture previously employed but with others since developed as a result of joint research carried out during the year in conjunction

with the staff of the Limmer and Trinidad Lake Asphalt Company, which, it is anticipated, should not only be equally satisfactory but should also be more convenient for use by the highway engineer.

Considerable assistance in this work was rendered by Mr. D. C. Broome, research chemist of the Limmer and Trinidad Lake Asphalt Company whose laboratory investigations furnished very useful information as to the conditions under which rubber can most usefully be employed in asphalt mixtures.

A paper by Mr. W. S. Davey, B.Sc., describing some of the work carried out on the use of rubber in bitumen for road surfacing materials was published in the Bulletin of the Rubber Growers' Association for May, 1936.

There is also useful progress to report in connection with the systematic study commenced last year of the preparation and properties of latex-cement mixtures for roadways, pavements and flooring for which work a special grant was made by the Rubber Research Institute, Malaya for a period of three years.

Methods have been devised for controlling shrinkage which is one of the principal difficulties experienced in the use of latex-cement mixtures and also for the use of Portland cement in place of the more expensive aluminous cement enabling a wider range of attractive products to be obtained.

Samples illustrating the use of latex-cement mixtures as an adhesive for glass or glazed tiles to cement were supplied to the R.G.A. for display on the Association's stand at the Building and other exhibitions, and arrangements were made for enquirers to be supplied with specially compounded latex suitable for the purpose.

Close co-operation has been maintained through the work with the investigations on road-surfacing which are being carried out under Professor P. G. H. Clements in the Highways Laboratory at the City and Guilds' Engineering College. This co-operation has been especially helpful in regard to the mechanical testing of latex-cement mixtures and joint experimental work is now in progress.

Co-operation with other Organisations

Co-operation on the usual lines was maintained with the Rubber Growers' Association, the Research Association of British Rubber Manufacturers, the Rubber Producers Research Association, the American Chemical Society, the British Standards Institution, the Electrical Research Association and with other research and trade organisations mentioned in previous reports. The discussions covered a wide range of subjects affecting various technical activities of the Committee but there is no important development to report in this connection.

PATENTS

As in previous years, abstracts of English patent specifications in respect of inventions relating to processes for the preparation and/or utilisation of raw rubber and latex were made for the information of the Rubber Growers' Association, the Rubber Research Scheme (Ceylon) and the Rubber Research Institute (Malaya) and copies of specifications of special interest were obtained for the research organisations in the East.

In conjunction with the Rubber Producers' Research Association steps were taken to obtain English patents in connection with inventions arising out of the work of the staffs in London and in the East.

Applications Sealed during 1936

444,925—Concentration of latex—Reciprocating Surface Process for Evaporation.

450,222—The use of hemicellulosic and linseed-cake meal extracts as creaming agents.

Complete Specifications Filed during 1936

12,053/36—Improvement of the centrifugal concentration of latex by the addition of organic liquids. (Communicated by the Rubber Research Institute).

Provisional Specifications Accepted during 1936

12,781/36—The preservation of latex by the use of an acid. (Communicated by the Rubber Research Institute).

14,704/36—Chlorination of Nitrite Crumb.

16,615/36—Preparation of chlorinated rubber from latex.

19,543/36—The preparation of softened rubber from stearate crumb. (Communicated by the Rubber Research Scheme, Ceylon).

23,187/36—Concentration of latex by creaming with a vegetable powder. (Communicated by the Rubber Research Institute).

23,188/36—Preparation of brominated rubber from latex.

28,735/36—Process for obtaining a very stable creamed latex by the use of a synthetic creaming agent. (Communicated by the Rubber Research Institute).

30,770/36—Process for improving the properties of latex cement mixtures for use in flooring, etc.

REPORTS ON INVESTIGATIONS FORWARDED TO CEYLON AND MALAYA DURING 1936

Latex Testing and Specification

Latex specification—colour of latex
Stability of latex

Creaming of Latex

Latex concentration (creaming)
Latex creaming agents prepared from linseed cake meal
Comments on tests in Malaya on synthetic creaming agents prepared in London
Latex creamed with vegetable powder
Hemi-cellulose and linseed cake meal creaming agents for latex.

Preservation of Latex

Preservation of latex with chemicals other than ammonia
Latex containing an acid preservative

Latex (general)

Quality of latex from Dartonfield Estate, Ceylon
Coagulation of latex on freezing
Miscellaneous reports on quality of latex

Investigations connected with the Preparation of Rubber

Softened rubber prepared in Ceylon
Clone rubbers from Malaya and Netherlands East Indies
Chlorinated and brominated derivatives of rubber prepared in London from preserved latex

Miscellaneous

Malayan mineral filler submitted to the R.R.I. Malaya
Quarterly progress reports on investigation of cement-latex mixtures.

(Sgd.) P. J. BURGESS
Chairman

(Sgd.) J. A. NELSON
Secretary

February, 1937

TECHNICAL APPENDIX

To the Annual Report of the

LONDON ADVISORY COMMITTEE

Latex

(1) Specification and Testing

As in 1935 considerable attention was paid to devising and developing methods for determining the quality of latex, especially the preparation of colour standards for liquid latex and methods for determining stability.

In order to obtain suitable standards the colour of many samples of latex was analysed by means of the Lovibond Tintometer, an apparatus which gives a numerical measure of colour in terms of the primary colours red, yellow and blue. The values given by latex are very small, and the apparatus is not altogether suitable for routine tests, but the information obtained was useful in the preparation of colour mixtures for matching individual samples of latex.

Although latex varies considerably in colour no difficulties in matching were experienced, but the principal problems were to devise a simple and suitable form of matching outfit with a limited number of colour slides having colours which are permanent, reproducible and moisture-proof. As freshly-tapped latex may vary from practically pure white to yellowish-white and may darken on storage, four different mixtures of titanium dioxide (white) and cadmium sulphide (yellow) were prepared using sodium silicate as a binder. To each was added a range of amounts of lamp black, giving a series containing 24 colour slides. It was found however that the dominant factor was the grey colour which masked the yellow and resulted in different observers matching a given sample with slides containing the same amount of carbon black but different amounts of cadmium sulphide.

After consultation with trade interests a modified outfit of colour slides was accordingly prepared consisting of nine shades using the same component materials in varying amounts, the basic colour being white with a very slight trace of yellow. The adoption of the colour standard outfit was under consideration by the Latex Joint Sub-Committee of the Rubber Growers' Association and the Rubber Trade Association at the end of the year.

Work was continued with the object of devising a suitable stability test for latex and particular attention given to the method

referred to in the last report involving stirring in the presence of zinc oxide. The apparatus for this purpose was designed and constructed in the Committee's workshops and duplicate apparatus supplied to the Rubber Research Scheme (Ceylon) and to the Rubber Research Institute (Malaya).

In view of the irregular results given by this method a study was made of the following variable factors:—(1) The quantity of latex of a fixed dry-rubber-content, (2) The amount and grade of zinc oxide, (3) The speed of stirring, (4) The ammonia content of the latex and (5) The temperature of testing. Following this investigation standardised conditions were adopted enabling satisfactorily reproducible results to be obtained.

The chief defect of the test is the time required for coagulation with zinc oxide (from 1 hour to more than 24 hours). Other coagulants are being tried and sodium silicofluoride appears promising because it enables the test to be carried out in a few minutes and it is not necessary to standardise the amount and grade as in the case of zinc oxide. Experiments are also being made with increased speeds of stirring.

A method for determining stability by very rapid stirring, in use in America, was submitted to a preliminary investigation, but it was found difficult to obtain a satisfactory end-point and for some latices the method appeared to be altogether unsuitable.

(2) Freezing of Latex

Latex is now being exported to countries where temperatures below 0°C are frequently encountered, and during the year enquiries were received from brokers as to the lowest temperature which preserved latex will withstand without coagulation. As no definite information on the subject could be obtained from a study of the literature and from enquiries made in the United States of America, preliminary tests were carried out in which different types of commercial latices were frozen to a solid mass at temperature between —12°C and —20°C. After subsequent storage at room temperature some types reverted to liquid latex but others were found to be coagulated. Creamed and centrifuged latex showed the greatest tendency to coagulate on freezing (after two days at —20°C), which was found to be due to the removal of serum substances. Revertex showed greater resistance to coagulation than any other type of concentrate. There was variation in the behaviour of 38/40 per cent latex from different sources, but some samples after being kept for ten days at —20°C reverted completely to latex on thawing. Coagulation was retarded by the addition of ammonia or protective colloids such as saponin.

(3) Preservation of Latex

(a) *Dartonfield Latex*

Among the samples of latex examined, one drawn from the first trial consignment shipped from Dartonfield Experimental Station of the Ceylon Rubber Research Scheme is of special interest. The latex, which was prepared in accordance with the recommendations of the Rubber Research Institute, Malaya, was of excellent quality both as regards the colour of the latex and of the dried film, freedom from solid matter, high stability and film strength.

(b) *Disinfectants*

In continuation of the experiments of the Rubber Research Institute referred to in the last report further samples preserved with chemicals other than ammonia were received for examination. Some of the disinfectants were satisfactory preservatives, but it was necessary to add a small amount of ammonia in order to reduce the viscosity to that of ammonia-preserved latex. On the whole the samples were of excellent quality and very suitable for commercial use, but the strongly poisonous character of the preservatives used is a distinct disadvantage.

Discussion with the Rubber Growers' Association led to experiments by the Rubber Research Institute on the preparation of latex with an acid reaction, and it was discovered that one of the acids frequently used as a coagulant would preserve undiluted field latex for long periods when used in suitable proportions. On arrival in this country the latex contained 7½ per cent of its weight of rubber in the form of coagulum and the surface froth showed a marked tendency to coagulate. A further sample containing saponin was free from coagulum and the froth did not coagulate so readily. Although the dry rubber obtained from the latex by coagulation with ammonia was of excellent quality the scope for commercial utilisation in directions where acid latex may have advantages is greatly limited by the difficulty experienced in compounding with the usual vulcanising agents, even in the presence of stabilising agents. After sundry trials the most promising outlet appeared to be for the preparation of chlorinated rubber and this led to a somewhat extensive investigation described in section 5 of this report.

(4) Latex Concentration

(a) *Creaming*

As indicated in the report for 1935 aqueous extract of linseed cake meal appeared to be one of the most promising creaming agents discovered in the Committee's laboratories. This material is obtained from many countries and a set of crude and purified extracts was

accordingly prepared from meal of widely diverse origins for trial in Malaya with fresh latex.

According to a report from the Rubber Research Institute the extracts were on the whole good creaming agents, but a higher concentration was necessary than is customary when using tragon seed gum. The purified materials were in most cases more efficient than the crude extracts.

Reports were also received from the Rubber Research Institute on the methylated starch and hemicellulose prepared during 1935. The results confirmed that these materials were creaming agents of latex, but the dry-rubber-content of the concentrates was not sufficiently high to warrant further work with a view to commercial application. In view of the discovery by the Institute of a local source of new and cheap creaming agents of considerable promise, the work in London has been discontinued for the time being. A sample of latex prepared in Malaya with this creaming agent was found to be satisfactory, although prepared from latex which was somewhat abnormal as regards stability.

Further experiments on the concentration gradient in the cream layer led to the development of a continuous process for latex creaming in which the highly concentrated surface layer is removed. If the rate of removal of this layer is sufficiently slow it is obvious that a higher concentration than usual must be obtained, but owing to the very slow rate of flow required in small scale experiments it is difficult to determine in London whether the method is practicable on a large scale. The present procedure recommended by the Rubber Research Institute to estates involves the removal of 80 per cent of the cream every 48 hours, and as the staff of the Institute are of opinion that the advantages of the continuous process are unlikely to warrant any alteration, no further action is being taken.

(b) *Evaporation*

The apparatus developed in the London Advisory Committee laboratories and referred to in the last report was despatched to the Rubber Research Institute, Malaya. Considerable attention had first to be paid to the surface treatment of the metal parts in order to avoid discolouration of the latex. Experiments were made with proprietary paints, chlorinated rubber, bitumen and chromium and rhodium plating. None was entirely satisfactory, but it was decided to adopt rhodium plating which appeared to be the most promising treatment. This however proved to be unsatisfactory in tests carried out in Malaya, and in the apparatus supplied subsequently to the Director of the Rubber Research Scheme (Ceylon) at his request it was decided to use stainless steel.

A sample of latex concentrated in the apparatus in Malaya to a dry rubber content of over 68 per cent without the addition of pro-

tective colloids was found to be of satisfactory quality on examination in London and was favourably reported on by the trade, who have requested a larger sample.

(c) *Filtration*

At the request of the Rubber Research Institute preliminary experiments have been made in London with a view to obtaining the best materials for use in concentrating latex by a method of filtration suggested by the staff of the Institute. A sample of latex prepared by this method in Malaya was examined in London and found to be satisfactory.

(d) *Centrifuging*

Two interesting samples of concentrated latex consisting of (a) ordinary centrifuged cream and (b) centrifuged concentrate prepared from the skim fraction were prepared in Malaya at the request of the Committee. Micro-photographs indicated a preponderance of large particles in the centrifugal cream and small particles in the concentrate from the skim. There was however no complete separation of large and small particles in either latex and it was considered that the concentrate from the skim would not have any enhanced practical value, as, for example, in proofing.

(5) Halogen Derivatives of Rubber from Latex

With a view to finding a use for the acid latex from Malaya (see section (3) (c)) it was treated with chlorine gas for the purpose of obtaining chlorinated rubber, but the coagulation of the froth caused considerably difficulty. This difficulty was avoided on using chlorine water instead of gas but it was found more convenient to chlorinate with a mixture of hydrochloric acid and sodium chlorate. The method was also found to be suitable for the chlorination of suitably stabilised ammoniated latex. In the presence of excess reactants finely divided white or pale cream powders were obtained, which contained over 50 per cent combined chlorine and swelled considerably in most solvents without dissolving. Numerous attempts to obtain a soluble product containing over 60 per cent combined chlorine suitable for paint manufacture were unsuccessful. The products obtained could be moulded at temperatures from 110° to 130°C, and a sample was sent to the Rubber Growers' Association for use in their experiments on expanded chlorinated rubber.

Partially chlorinated products obtained with smaller amounts of hydrochloric acid and sodium chlorate and partially brominated rubbers, prepared by the addition of bromine water to stabilised ammonia-preserved latex or acid latex were superior after vulcanisation to plantation rubber as regards resistance to oils and solvents,

but were decidedly inferior to the synthetic materials Duprene and Thiokol. The brominated proved to be more stable than the chlorinated rubbers.

Interesting features of partially halogenated rubbers are (1) the property of vulcanisation in the presence of zinc oxide without sulphur, (2) the increased speed of reaction with sulphur at vulcanising temperatures and (3) the comparative inertness of accelerators. A range of hard rubbers prepared from the brominated material appeared to have a higher softening point than ebonite and in view of their promising character were sent to the Research Association of British Rubber Manufacturers for an opinion as to their suitability for industrial purposes.

(6) Road Surfacing and Flooring Materials

The work on road and floor surfacing materials commenced last year has been largely devoted to a study of mixtures of latex and aluminous cement, but attention has also been given to the possibility of using Portland cement.

The work carried out during the year on aluminous cement-latex compositions comprises (a) a microscopic study of the structure of the finished product, (b) an attempt to follow the processes of hydration during the mixing and setting of the material, (c) an examination of the mechanical properties of the products obtained, (d) a study of the physical properties of the mixture which require consideration in connection with practical processing such as speed of setting, shrinkage, etc.

The usual methods of section cutting and polishing were not suitable for studying the microstructure of cement-latex mixtures owing to the composite nature of the material, which contains both soft rubber and very hard cement grains. Attempts to cut sections of the material frozen in solid carbon dioxide and to grind sections immersed in liquid air were unsuccessful as it was not possible to obtain a sufficiently thin section or a good polished surface. Various other methods were attempted and finally success was attained by grinding and polishing small pieces of the material vulcanised to a hard condition by immersion in molten sulphur. By this means the structure of cement-latex mixtures was shown to consist of incompletely hydrated cement grains embedded in a matrix of cement hydration products and rubber. The matrix appears to comprise a continuous phase of rubber, in which are distributed the cement hydration products. In the harder and more cementitious materials the hydration products form a second continuous phase, interlocking with the rubber, but in the softer materials they are dispersed throughout the rubber and function only as a filling material.

It is generally assumed that the purpose of adding cement to latex is to fix the free water by chemical means. The amount of combined

water in cement-latex mixtures was found to depend almost entirely on the nature of the stabilising agent present in the latex and was generally not greater than 3 per cent calculated on the cement except in the presence of caustic potash when the combined water amounted to 11 per cent, an amount similar to that which combined with cement under comparable conditions in the absence of latex and potash. Mixtures containing a high proportion of combined water were much harder than those in which only a small amount of hydration occurred.

The machines ordinarily employed for testing rubber or cement are unsuitable for determining the mechanical properties of cement-latex mixtures. A machine for testing tensile strength of the mixture and another for measuring co-efficient of restitution have been designed and constructed therefore in the workshops of the department. Examination of materials containing varying proportions of rubber to cement has shown that the resiliency increases with the proportion of rubber present and that very different products are obtained by varying the nature and amount of the protective colloid in the latex.

Microscopic examination and hydration experiments indicated that much of the cement plays the part of an inert filler. Further experiments with certain mixtures showed that no falling off in the mechanical properties occurred when one-third of the cement was replaced by an inert filler such as limestone dust, but when two-thirds were replaced a slight decrease in strength was observed; with all the cement replaced by an inert filler, a very weak product was obtained.

Although cement does not completely dehydrate latex and can in some cases be partly replaced by an inert filler it undoubtedly serves an essential purpose in promoting quick setting and mechanical rigidity.

It is considered essential that material to be used for road or floor surfacing should remain "workable" for at least three quarters of an hour in order to allow adequate time for mixing and laying and that it should set sufficiently hard to bear light traffic within twenty-four hours. By the addition of protective colloids and certain other materials, in carefully controlled proportions, to cement-latex mixtures it was found possible to adjust the workable period and setting time within fairly wide limits.

Preliminary studies indicated that the shrinkage which frequently occurs with cement-latex mixtures is connected with the relative amounts of water combined with the cement and that lost by evaporation. A method of controlling this loss was devised and evidence was obtained that shrinkage can be considerably reduced.

The use of the comparatively expensive aluminous cement is due to the fact that cheaper cements such as Portland cause immediate coagulation on mixing with latex. This coagulation can be avoided by the addition of large quantities of a protective colloid which inter-

feres however with the setting of the cement and results in a much inferior product. One of the causes of coagulation was found to be the presence of gypsum which is invariably added to the Portland cement clinker before grinding. Tests made with Portland cement ground with and without gypsum have shown that the addition of gypsum gives rise to more rapid coagulation of the latex, increases the time of hardening of cement-latex mixtures beyond practicable limits and results in a weaker product. As Portland cement is much lighter in colour than aluminous cement it is possible by omitting the addition of gypsum during manufacture to obtain satisfactory rubber-cement products in bright colours particularly attractive for flooring.

During the year an enquiry was received for a suitable adhesive for attaching glass to Portland cement which is of importance in connection with some types of building. Cement-latex mixtures were known to be promising and a few experiments were made and samples prepared to demonstrate their value for the purpose. Samples were shown including the fixing of glazed tiles to cement at the Building Exhibition at Olympia and a few enquiries were received and referred to suppliers of latex suitable for the purpose.

Rubber

(1) Nitrite Crumb

Reference was made in the last report to an experimental highway in which the binding material is a mixture of asphalt and rubber crumb prepared by a method devised by the London Advisory Committee staff (B.P. 395,755). The roadway continues to give satisfactory results and still retains a better matt non-skid surface than the asphalt control. In view of the possible importance of this development to the plantation industry arrangements were made with the Rubber Growers' Association and the Limmer and Trinidad Lake Asphalt Co. for closer laboratory co-operation and for further large-scale trials.

The joint laboratory work has indicated that it is not necessary to dissolve the crumb in the bitumen, thus reducing the cost of preparation, and that latex can be used with greater facility than crumb and much less rubber is required to achieve a given effect. Laboratory tests have also shown that rubber confers superiority on asphaltic cement mixtures in respect of (1) softening point, (2) ductility, (3) elasticity, (4) resistance to flow, (5) susceptibility factor, (6) asphalt-viscosity index and (7) fluidity factor. A material possessing these advantages should inevitably show a less tendency to "flush-up" on the road and if the original specification is such as to give a non-skid surface there is a fair degree of certainty that it will remain in a similar condition. One of the defects to which certain types of bituminous road surfacings are subject is the gradual

displacement of the chippings originally forming the riding surface by a smooth film of "liquid" bitumen, and it is felt as a result of the present work that the risk of such a transition is materially reduced with asphaltic cements of the type under consideration when made into asphalt mixtures.

Attempts were made to determine in the laboratory the effect of rubber on the properties of materials of asphaltic cement with aggregate, but the results are somewhat irregular and there is some doubt as to the practical value of the information obtained. Data have been obtained, however, which have an important bearing on the nature and properties of the materials to be employed in large scale trials.

Arrangements have been made for three trial sections of road to be laid early next year, *viz.* one similar to that laid previously in which the crumb was uniformly dispersed in the bitumen, another in which the crumb is mixed with the bitumen without solution and a third with rubber in latex form.

(2) Rubber for use in the Electrical Industry

Experiments have been proceeding at the Rubber Research Institute with the object of preparing a special type of rubber having a low water absorption due to the removal of part of the serum substances generally present in standard grades of rubber. Samples have been received which absorb from a damp atmosphere about one-quarter of the amount of moisture absorbed by average crepe. Arrangements were made for technical trials with this rubber by manufacturers suggested by the Research Association of British Rubber Manufacturers.

(3) Softened Rubber

A sample of softened rubber prepared by the Ceylon Rubber Research Scheme from rubber in crumb form was found to have similar vulcanising and ageing properties to those of some grades of commercial softened rubber, but its manipulative properties were not so satisfactory.

(4) Vulcanised Crepe

Two samples of vulcanised crepe prepared by the Ceylon Rubber Research Scheme were examined by immersion in boiling water, freezing and swelling in organic solvents. The value of the material for use in moulding Portland cement, plaster etc. with a view to giving a "key" for attachment to other materials or for the purpose of producing a pleasing appearance was demonstrated at the Building Exhibition held at Olympia.

(5) Clone Rubber

A number of samples drawn from well-known clones were examined during the year, and considerable data are being accumulated concerning the quality of the rubber from different sources. It is proposed to prepare a critical review when sufficient information has been obtained to draw authoritative conclusions.

Rubber-Shellac Mixtures

A process has been devised in conjunction with Mr. A. K. Thakur of the Indian Lac Research Institute for obtaining a moulding powder consisting of an intimate mixture of shellac and unvulcanised rubber, with the addition of vulcanising ingredients and other fillers if desired. A set of samples has been prepared and forwarded to the London Shellac Research Bureau, for submission to different authorities with a view to determining their suitability for a number of purposes.

(Sgd.) G. Martin

THE RUBBER RESEARCH INSTITUTE OF MALAYA

STAFF

at the 31st December 1936

Director	H. J. Page, M.B.E., B.Sc., F.I.C., F.I.R.I.
Botanical Division	
Senior Botanist	C. E. T. Mann, M.Sc. (Lond.)
Botanist	C. C. T. Sharp
Botanist	E. D. C. Baptist, Ph.D. (Lond.), M.Sc., A.R.C.S., D.I.C.
Asst. Botanist	K. N. Kaimal, B.A. (Madras)
Asst. Botanist	T. V. Vaidyanathan, B.Agric. (Bombay)
Chemical Division	
Senior Chemist	E. Rhodes, Ph.D., M.Sc. (Leeds), A.I.R.I. (Sc.)
Chemist	K. C. Roberts, Ph.D. (Lond.), M.Sc. (N.Z.), A.I.C.
Chemist	J. D. Hastings, B.Sc. (Lond.)
Chemist	J. H. Piddlesden, M.Sc. (Lond.), A.R.C.S., D.I.C., A.M.I.Chem.E.
Advisory Officer attached	A. Moore, B.Sc., (Lond.), A.R.C.S.
Asst. Chemist	K. C. Sekar, B.A. (Madras)
Pathological Division	
Pathologist	F. Beeley, B.Sc. (Leeds)
Pathologist	R. P. N. Napper, M.A., Dip. Agr. (Cantab.)
Asst. Pathologist ...	K. P. John, B.A., (Madras)
Soils Division	
Senior Soils Chemist ...	C. G. Akhurst, B.Sc. (Lond.), A.R.C.S., A.I.C.T.A.
Soils Chemist	R. A. Hamilton, B.Sc., B.Agric. (Belfast), Dip. Agr. (Cantab.), A.I.C.T.A.
Asst. Soils Chemist ...	K. S. Pillay, B.A. (Madras), F.C.S.
Experiment Station	
Manager	H. W. Foston, A.I.S.P.
Asst. Manager	T. N. Dickson, A.I.S.P.
Secretary	H. S. Blacklin

LONDON ADVISORY COMMITTEE FOR RUBBER RESEARCH (CEYLON & MALAYA)

at the 31st December 1936

Mr. P. J. Burgess, M.A., F.C.S., (Chairman) Mr. W. J. Gallagher, M.A. Mr. H. Eric Miller Mr. G. H. Masefield Mr. George Brown Sir Herbert Wright	Nominees of The Rubber Growers Association
Lt. Col. J. Sealy Clarke	Nominee of the Research Association of British Rubber Manufacturers
Sir F. A. Stockdale, K.C.M.G., C.B.E.	Nominee of the Colonial Advisory Council of Agriculture and Animal Health
Mr. J. Lornie, C.M.G., M.A., B.Sc.	Nominee of the Malayan Governments
Dr. W. Youngman, D.Sc., Ph.D.	Nominee of the Ceylon Government
virtute officii: The Director, Imperial Institute	Sir H. A. F. Lindsay, K.C.I.E., C.B.E.
virtute officii: The Director, Botanical Laboratories, Imperial College of Science and Technology	Professor V. H. Blackman, M.A., D.Sc., F.R.S.
virtute officii: The Director, Imperial Mycological Institute, Kew	Mr. S. F. Ashby, B.Sc.
virtute officii: The Director, Rothamsted Experimental Station	Sir E. John Russell, O.B.E., D.Sc., F.R.S.
Dr. H. A. Tempany, C.B.E., D.Sc., F.I.C.	Co-opted
Secretary: Mr. J. A. Nelson, B.Sc.	Imperial Institute, London, S.W.7.

Technical Sub-Committee

All the members of the London Advisory Committee with the addition of the following co-opted members:—

Mr. B. D. Porritt, M.Sc., F.I.C., F.R.S.E., F.I.R.I.
Mr. I. D. Patterson, B.A., B.Sc.E., F.I.R.I.
Mr. H. N. Ridley, C.M.G., M.A., F.R.S.
Mr. W. C. Smith, F.C.S., F.I.R.I.
Dr. D. F. Twiss, D.Sc., F.I.C., F.I.R.I.
Dr. H. P. Stevens, M.A., Ph.D., F.I.C.
Prof. R. G. H. Clements, M.C., M.Inst.C.E.
Mr. G. E. Coombs, B.Sc.

STAFF

Superintendent of Laboratories ...	G. Martin, B.Sc., A.I.C., F.I.R.I
Chemist	W. S. Davey, B.Sc., A.I.C., F.I.R.I.
Chemist	H. C. Baker, B.Sc., A.I.R.I.
Chemist	W. G. Wren, B.Sc., A.R.C.S.
Technical Assistant	A. T. Faircloth

Edited by H. J. Page on behalf of the Board of the Rubber Research Institute of Malaya.